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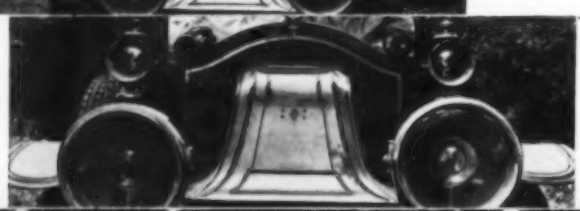

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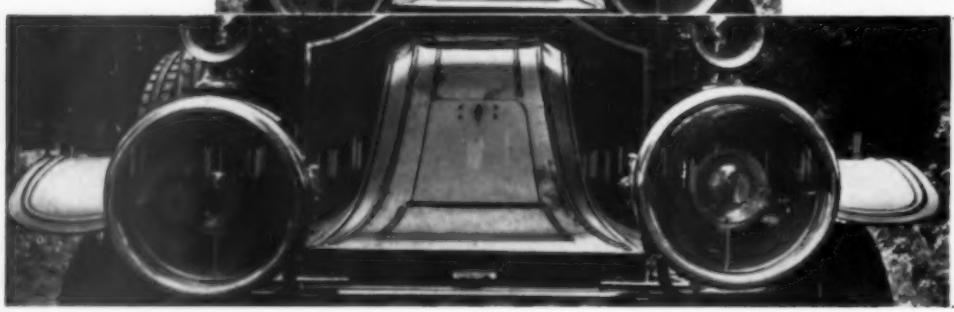

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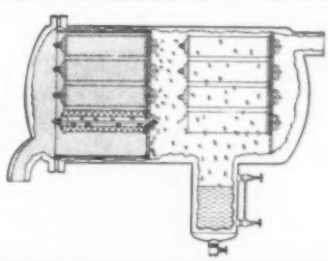

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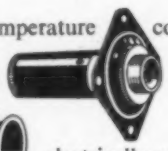

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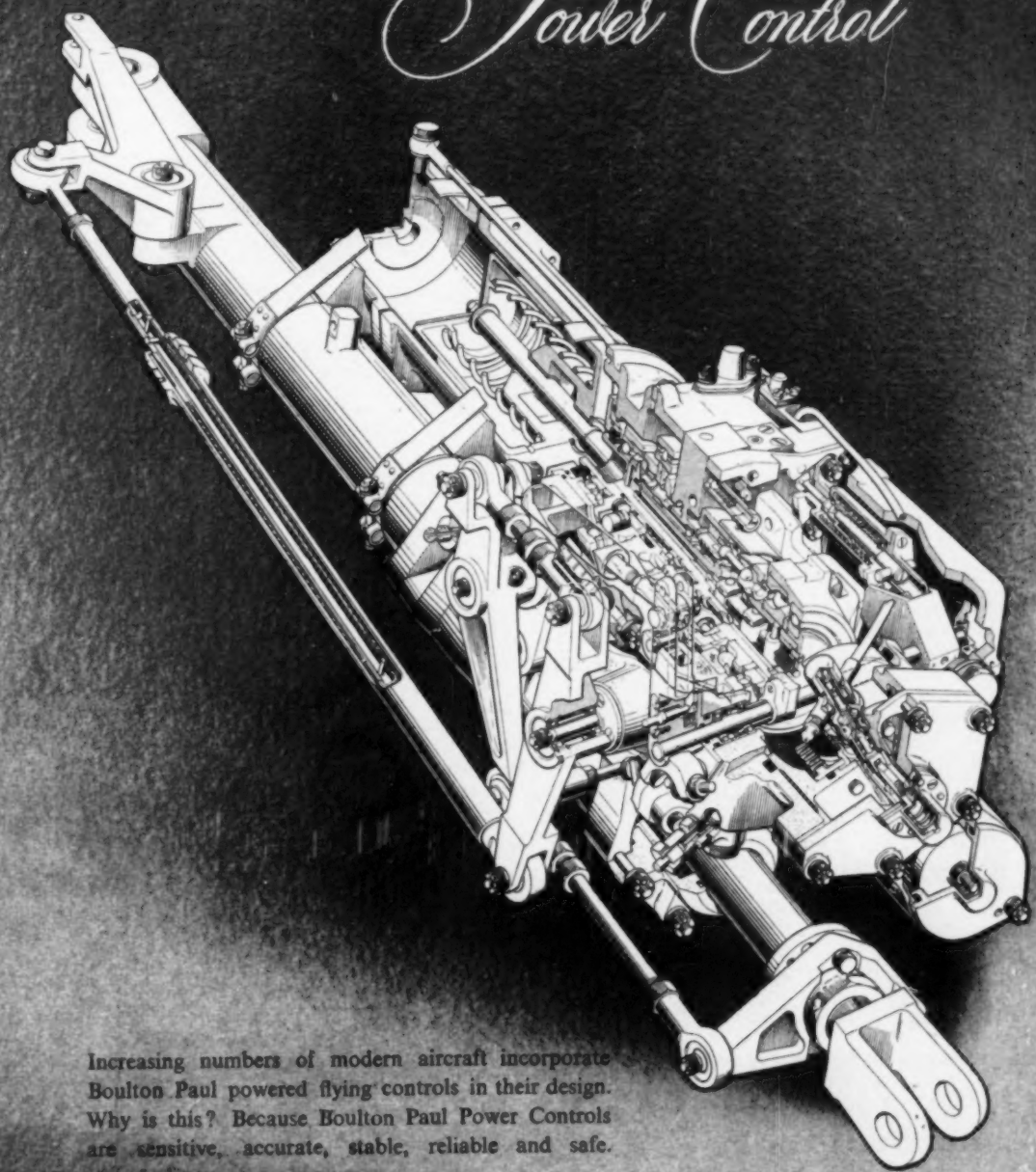

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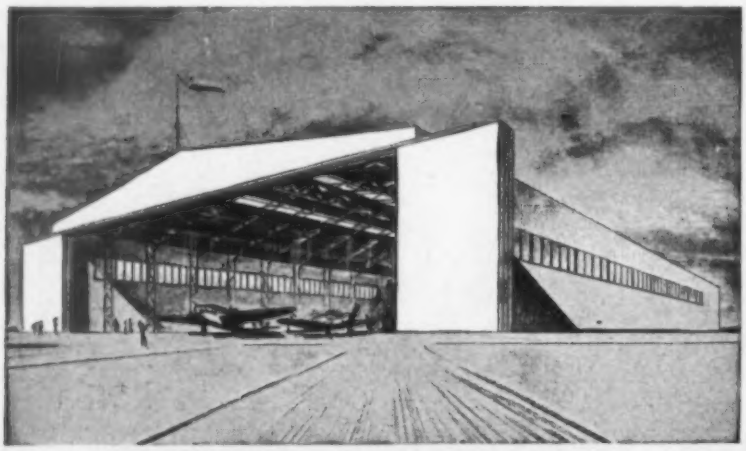

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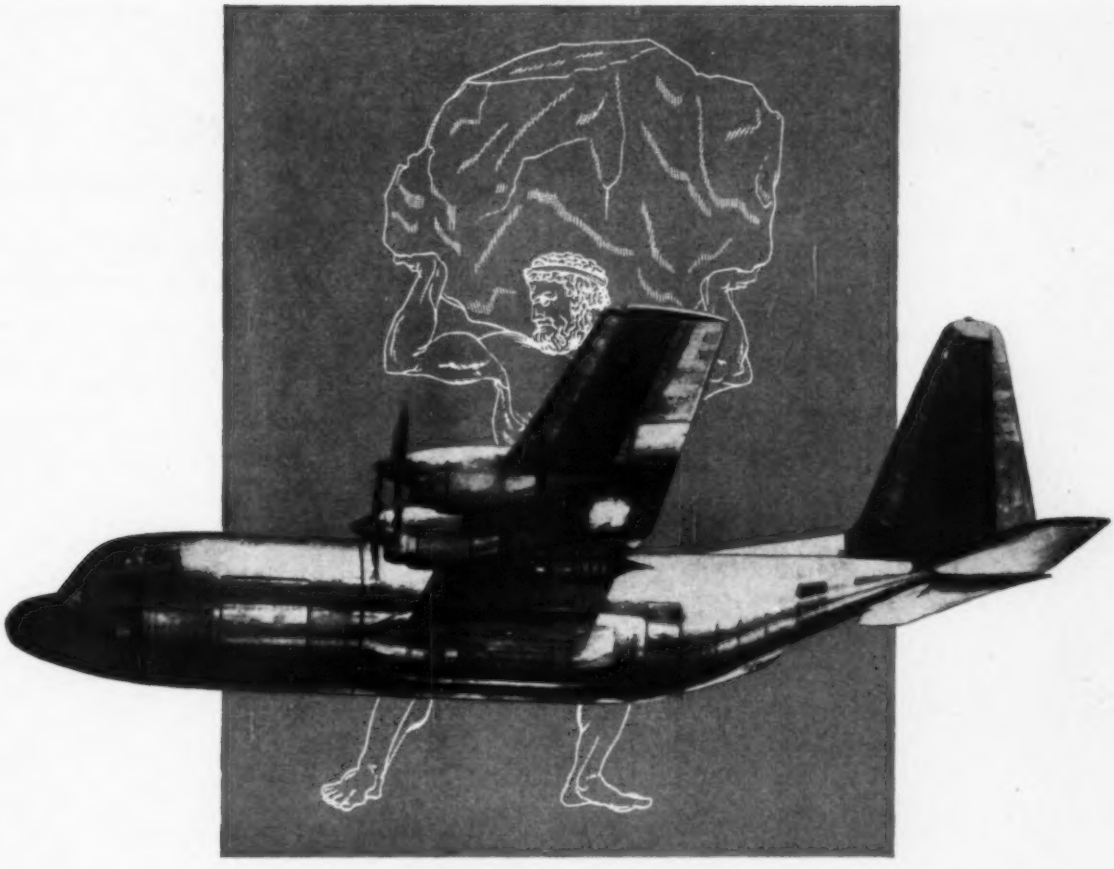

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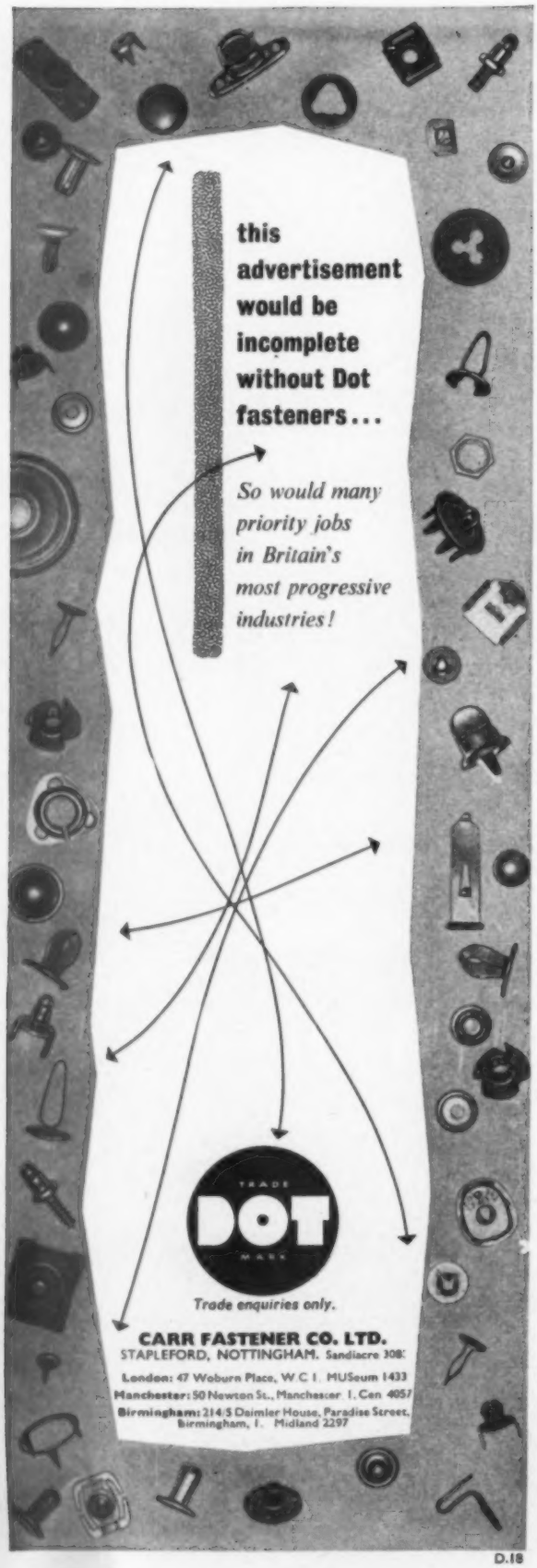
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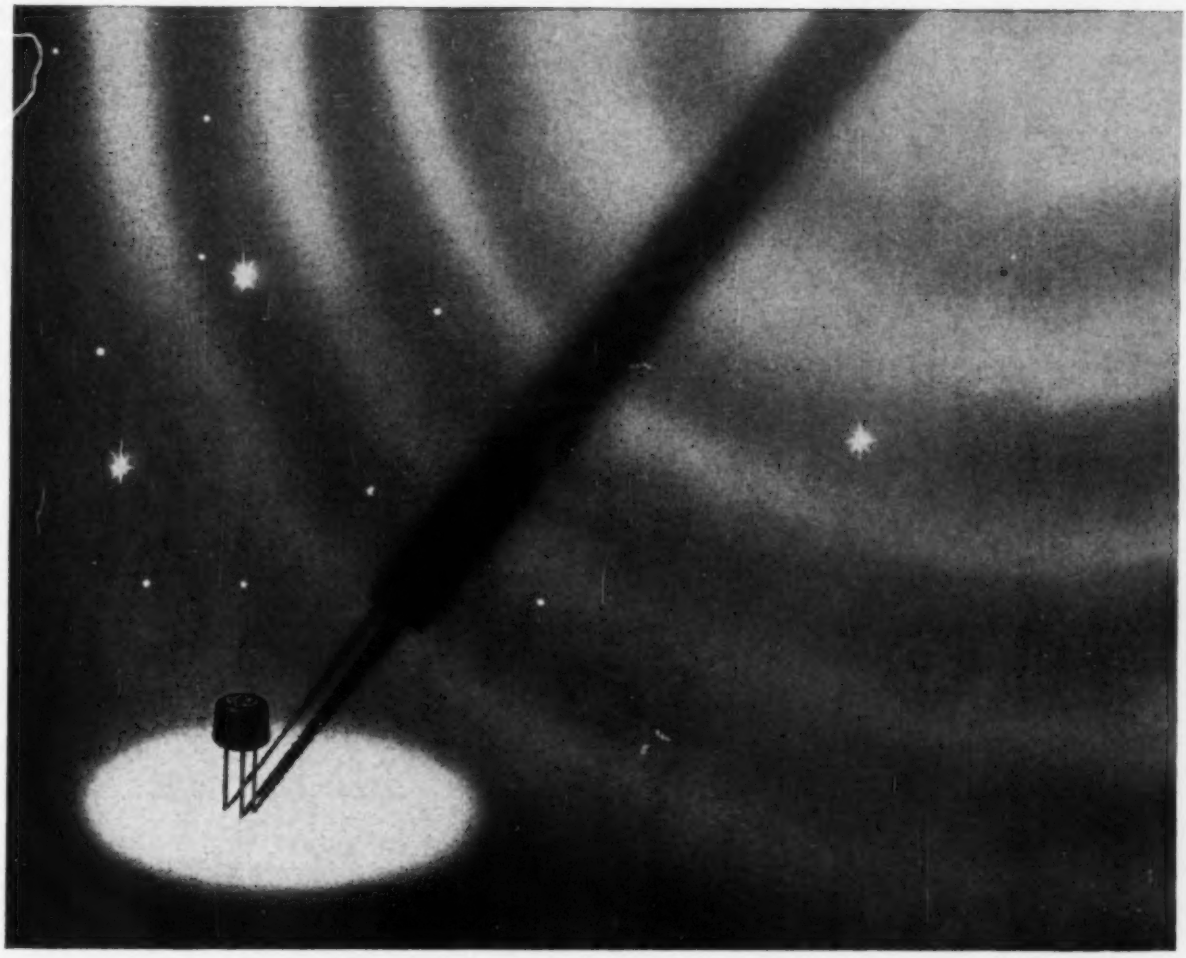

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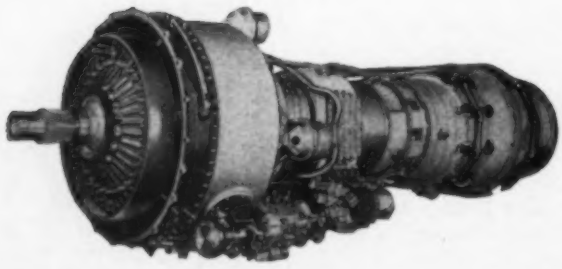

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2547 Vol 72 FRIDAY 15 NOVEMBER 1957

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Britain's VTO Airliner

TO report that a six-engined VTO airliner is now flying in Britain is to report no more than the truth; and by so describing the Fairey Rotodyne we may hope to direct a due measure of attention to an aircraft having unique capabilities and excellent commercial prospects.

News of the Rotodyne's trouble-free initial flights, after an extremely satisfactory and notably brief period of ground testing, cast a bright and steady beam through an otherwise sombre, troubled week in British aviation. Congratulations are in order jointly to the Fairey company, for their courageous venture in aeronautical engineering, and to Napier, for having rendered that venture feasible by developing their novel "power system" (such indeed is the scheme whereby the two Elands deliver their output either to the propellers or to the auxiliary compressors feeding the tip-mounted Fairey pressure-jets). And while the cigars are circulating, a Churchill Special for the Minister of Supply—staunch godfather of this first Rotodyne and of the plumper brother soon to follow it.

The civil and military applications of the large convertiplane—a class wherein the Rotodyne now assumes pre-eminent status—are as varied as they are manifold, and among them is one which illustrates with particular vividness the commercial prospects. We have in mind the carrying of 40 passengers on the London-Paris run—a performance which, though unlikely to be realized as soon as others in the Rotodyne repertoire, continues very much in mind. The "fixed-wing" journey time, including surface transport to and from airports, is four and a half hours—a time which the Rotodyne might reduce to an hour and three-quarters.

But whatever may come about in the way of city-centre-to-city-centre or airport-to-city-centre operations (and American interest continues very lively in this regard), the "outback" and "island hopping" applications of the Rotodyne offer their own special rewards. The big island groups invite—and doubtless have already been accorded—the closest attention by the Fairey salesmen.

For short-haul work a three-car ferry and a 48-seater coach version are offered. Add the built-in rear-loading facility; add, too, the ready possibility of mixed-traffic operation, and the Rotodyne must be adjudged as versatile as it is unconventional.

Back in the Nuclear Club

"IT'S over, and can't be helped, and that's one consolation, as they always say in Turkey, ven they cuts the wrong man's head off." Thus, like Sam Weller (though avoiding, no doubt, the reference to our NATO ally), might Air Chief Marshal Sir Harry Broadhurst have summed up his own feelings—and Bomber Command's—about the R.A.F. placings in the S.A.C. bombing competition. The Valiants and Vulcans failed to do well: not through lack of effort or skill, but mainly through a combination of adverse circumstances—malfunctioning of electronic equipment; operations at an altitude much lower than the V-bomber crews prefer; and, in the case of the Vulcans, comparative unfamiliarity of crews with their machines.

Yet Sir Harry rightly stresses the benefits of the contest. The R.A.F. crews and their U.S.A.F. counterparts have become "mentally integrated to an extraordinary degree"; S.A.C. has been informally invited to take part in the R.A.F. competition next year; and a satisfactory exchange of information exists between the two Commands. All to the good; for what matters above all is the high standard set by the Americans and the experience gained by the V-bomber crews of working overseas. Suez gave Valiant crews a taste of this, and the tropical atmosphere of Pinecastle has provided an even stiffer lesson.

Sir Harry summed up one aspect of the competition when he said, "We are back in the nuclear club." But the technical implications must now be taken to heart by his Command. Much remains to be done before it becomes a wholly effective nuclear force.

FROM ALL QUARTERS

BIG BROTHER: Russia's record-breaking twin-turbine helicopter, the Mi-6, which, as recorded last week, set up a new world record by lifting 26,464 lb to 7,874ft, seen with a smaller member of the Mi family, a piston-engined 3/5-seater Mi-1.

New M.E. Command, More R.A.F. Britannias

FORMATION of a new command in the Middle East, to be known as Aden Command, has been announced by Mr. Duncan Sandys, Minister of Defence. Operative from April 1 next, and with direct responsibility to London, the command will control all British land and air forces in the Arabian Peninsula and in British Somaliland, and Naval forces in the Persian Gulf.

Mr. Sandys, who made the announcement in the course of last week's debate on the Queen's Speech, said that it had been decided to separate the East African area from the Middle East Command. An element of the Strategic Reserve would be stationed in Kenya.

It was intended eventually to establish an integrated Army and Air Force command in Cyprus, under a single commander. The internal situation, however, made it necessary for the time being to postpone this amalgamation. [According to a London newspaper, the new command is to be headed by an R.A.F. officer, A. V-M. M. L. Heath. No confirmation of this report is available from the Air Ministry at the time of going to press.]

Going on to speak of air trooping, the Minister disclosed that the number of Britannias for Transport Command had been increased to 20, a further seven Britannia 250s having been ordered.

Sputnik II Transmissions Cease

ONLY seven days after the launching of the second artificial Earth satellite by Soviet Russia, a Moscow announcement reported that medical and biological observations had been completed in connection with Sputnik II, and that further observations would be carried out optically. No mention was made of the dog inside the satellite. An official Tass statement on Sunday last, November 10, gave the following information:—

"The second artificial Earth satellite continues its movement for the eighth day. By 6 p.m. (3 p.m. G.M.T.) on November 10 it had completed 103 circuits round the Earth, covering 4,740,000 km (2,950,000 miles).

"The launching of the second artificial Earth satellite, equipped with complex scientific instruments and instruments for transmitting the data of measurements back to Earth, has been a further considerable contribution to the task of studying physical and biological phenomena in conditions of cosmic flight.

"The programme of scientific observation connected with the reception of data from the satellite was calculated for seven days. At present this programme of scientific observations has been completely carried out. Valuable medical and biological data have been obtained on the conditions for the existence of living organisms during prolonged cosmic flights; material on the intensity of solar radiation and on the shortwave, ultra-violet and X-ray parts of the spectrum; cosmic rays; the dispersal of radio waves; data about temperatures, etc. The data which have been obtained are being subjected to careful processing and study.

"The radio transmitter of the satellite, emitting radio signals on frequencies of 40 and 20 megacycles, and the telemetrical instruments on board used for the programme of measurements have ceased functioning. Observations of the movement of the second artificial Earth satellite and the forecasting of its further movements will be carried out with the help of optical and radar means, and the same applies to the first satellite and its carrier rocket. . . ."

Scientific comment in this country, based on the fact that the first satellite's radio transmissions continued for three weeks, and that the second satellite was very much heavier and more fully instrumented, tended to conclude that the cessation of transmission by the second Sputnik was not, in fact, according to plan.

In the U.S.A., it was announced on November 8 that the U.S. Army was to use a modified Jupiter-C missile to launch an Earth satellite, in addition to the Vanguard project of the Naval Research Laboratory. The previous evening, President Eisenhower had claimed that the U.S.A. had solved the re-entry problem of space missiles, and he had disclosed the appointment of Dr. J. R. Killian, president of Massachusetts Institute of Technology, as a special co-ordinator in the field of science and technology.

NEW CAN, WET START: S/L. H. G. James, A.F.C., D.F.M., a flight commander of No. 46 Squadron, R.A.F. Odiham, puts to use the tankard given to him by squadron colleagues to commemorate completion of his 6,000th flying hour. L. to r.: F/L. J. W. Tritton, S/L. H. G. James, F/O. I. M. Calder and F/L. T. A. Mackenzie.

U.K. Megaton No. 3

IT was officially announced on November 9 that the previous day the third British megaton-yield weapon was successfully detonated at a high altitude in the neighbourhood of Christmas Island. It was dropped from a Valiant (fitted with steel vizors over the cabin windows) of No. 49 Sqn. with the following crew: S/L. B. T. Millett, captain; F/O. M. A. Pringle, co-pilot; F/L. F. G. Corduroy, navigator; and F/L. J. A. Tuck, air signaller.

Discussing Guided Flight

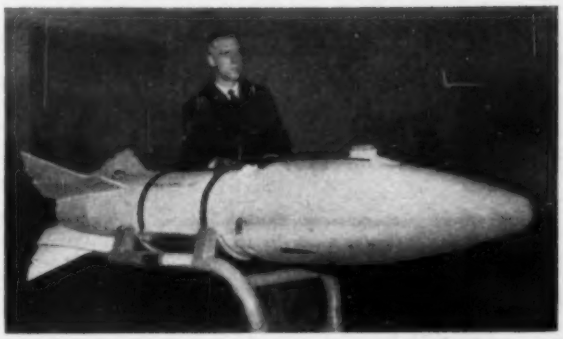
THE inaugural lecture of the newly-formed Guided Flight Section of the Royal Aeronautical Society is to be held on Thursday next, November 21, at the Royal Institution. Mr. J. Serby, C.B.E., B.A., F.R.Ae.S., Director-General of Guided Weapons at the Ministry of Supply, will be the speaker, and his subject is *Guided Weapons and Aircraft—Some Differences in Design and Development.*

Russian Rockets

MOST of the giant Soviet parades through Red Square provide one or two glimpses into Russia's military arsenal, and the 40th anniversary of the October Revolution, held on November 7, was the occasion for the lifting of the curtain which has hitherto covered Soviet rocket weapons.

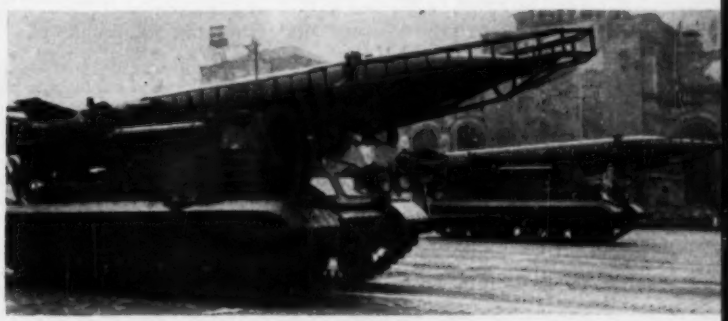
Following a pair of massive pieces of ordnance described as "jet guns" came eight anti-aircraft guided weapons, each mounted on a standard "Chevrolet-type" articulated truck. The configuration of the missiles can be seen in a photograph, there being a pointed ogive nose with cruciform receiving aerials (indicating semi-active homing), and cruciform wings, controls and boost fins all indexed in line. Firing weight must be of the order of 2,500 lb.

Eight tracked vehicles each carried an unguided tactical missile, best described as a "stretched Honest John." Clearly big enough to have a kiloton atomic charge, this weapon has a slender motor tube and cruciform tail fins. The next eight vehicles had a similar chassis on which was a large enclosed superstructure. Above this was a cylindrical housing for an unguided tactical weapon somewhat larger (at least with a larger warhead) than the previous model, and apparently designed to be placed in the vertical position by its container before firing. The next two vehicles used the same chassis as the previous eight, and very similar superstructure but carried a ballistic-type weapon roughly 30ft long and probably weighing about 10,000 lb (i.e., slightly smaller than Corporal). Finally there came two half-track personnel carriers towing two-axle trailers on which were larger ballistic weapons. The latter had pointed noses and cruciform fins. A rough estimate puts their length at 70ft, their weight at 40,000 lb and their range at 400 to 700 miles.



***AMERICAN** missiles, not previously illustrated: the Douglas MB-1 Genie (above) nuclear-head air-to-air weapon now in service with the U.S.A.F. Air Defense Command, the U.S.A.F. Douglas-built Thor IRBM (right) and (far right) the U.S. Army's Jupiter, a competing IRBM. One of the latter—or a mixture of the two—will be selected for production (for the U.S.A.F.) and will also be supplied to Britain.*

***SWEDISH** missiles include the Robot 304 air-to-surface guided weapon, here carried by a Saab A32 Lansen. The same body, warhead and guidance is used on the Robot 315, designed for firing from ships or land launchers: 315 has cruciform wings and a large boost motor.*



***RUSSIAN** missiles, revealed during the parade through Red Square, Moscow, on the 40th anniversary of the Bolshevik Revolution. Clockwise, from above: an unguided tactical weapon; an anti-aircraft missile; a guided bombardment missile; and (below) a strategic ballistic missile. Further details are given in a news paragraph opposite.*

250 VISCOUNTS BUILT

Sales Approaching 400 : A Review of the Market

IN its 4¼ years of service the Viscount has become a sort of national emblem, a symbol of the nation's highest aspirations as a builder of transport aircraft. When there are reverses on other fronts, there is always the Viscount to fortify national morale. The Weybridge and Hurn assembly lines, aggregating one mile in length and a model of their kind, are now building one aircraft every three days. "Flight" reviews the future trends of the Viscount market.

PROBABLY by the time these words are read the last of K.L.M.'s nine Viscount 803s—the Viscount which, it is expected, will be the 250th delivered—will have flown at Vickers, Weybridge. With total sales approaching 400 (the figure to date is 378), it seems an appropriate moment to review Viscount demand and supply.

The demand has come from 47 different operators in 32 countries. Total value of the 378 aircraft bought to date is around £150 million. To what extent is demand likely to continue? Sir George Edwards, managing director of Vickers-Armstrongs (Aircraft), recently forecast a total Viscount market of 500 aircraft, which appears to indicate—from the customer's point of view at any rate—an increasingly favourable balance between Viscount demand and supply.

Vickers announced in the summer that 12-month Viscount delivery dates can now be offered for "certain standard models." This compares with the two-year delivery periods which were quoted only a year or so ago, and it means that an operator ordering a 700 or an 800 now without too many change-orders could have his aircraft in service by this time next year—though he would probably have to wait rather longer for a series 810/840 aircraft. The idea of getting a new Viscount within a year is entirely fresh to capacity-hungry operators, and it may well remove the deterrent to Viscount sales which a two-year delivery period inevitably created and which sold so many Convair 440s.

This shorter delivery time may not alone permit Viscount production to continue at its present peak rate of ten aircraft per month; but it indicates—when two other market trends are also taken into account—that Vickers' estimate of a further 100 sales may be less than they might reasonably hope for.

There are, at the moment, 238 Viscounts in *airline* service, and the traffic they carry is growing at about the world average rate of 15 per cent per year. Though it would be an over-simplification to say that this will create an automatic repeat-order demand of between 30 and 40 aircraft a year into the sixties, considerable repeat-order business there certainly will be. The Viscount is the sort of transport which will go on going on: it has no rival, and it dominates a travel market which does not suffer from the re-equipment uncertainties of jet competition.

Expanding traffic creating repeat-orders is thus one factor which may sustain Viscount sales. Another may be the impact on the market of the 810/840 series. There is no knowing how great this might be, but it is fair to prophesy that there will be an appeal about 400 m.p.h. Viscount travel (made possible by the Dart 541 in 1960) which may stimulate a sizeable demand.

There is a world of difference between the effect upon an airline of a brochure and the impact of the real aeroplane in airline service. The 365 m.p.h. Viscount 810 will be in service (with Continental) next spring, and the Viscount 840 will be providing 400 m.p.h. travel in 1960.

So far, only 48 of the 810/840 model have been sold; but it may come about that regional Viscount travel as we know it today will be increasingly taken over by the 810/840, with the depreciated 700s—packed with high-density seats—moving into the local-service market.

It would, a year or two ago, have seemed fanciful to think of the Viscount as a local-service DC-3 replacement. But this is how at least two of its operators—B.E.A. and T.C.A.—are planning; and gradually it seems likely to dawn on others that the early type Viscounts which have worked off their first cost on the richer regional sectors, and which will not only be too small but too slow competitively and economically to exploit the higher density, 400 m.p.h.-plus traffic of the sixties, will provide a convenient replacement for the DC-3. Packed with up to 60 seats, Viscount 700s should—because of their low book-values—be as economical a proposition as the operationally more ideal modern replacements. There may be an airport problem (though only two places in B.E.A.'s domestic DC-3 network cannot take Viscounts), and 60 seats may be too many to fill in many branchline areas. But the portents are that a good many Viscount 700s will complete their lives on today's DC-3 routes—and this in itself may stimulate continued 700-type sales. An operator likes to know that his new plant can still be profitably utilized when its prime function is completed.

The heading picture is a composite photograph taken recently of one of the two Viscount assembly lines at Weybridge. (The line is of course straight, not curved.) The aircraft in the foreground is one of Eagle's 805s, those on the right are 806s for B.E.A. Right, the most recent product of the Hurn assembly lines—the fourth aircraft for Indian Airlines. To date Weybridge have built 78 Viscounts, and Hurn 169.

A further source of new Viscount business may well be Britain's independents. In the past year many of the restrictions which have frustrated their ambitions to operate new equipment have been lifted, and now Airwork, Hunting-Clan and Transair (Eagle soon) are all in the Viscount operating business, if as yet on a small scale. But the way is clear for Viscounts in Colonial-coach work, scheduled services, and trooping, and we may see quite a steady replacement of the independents' obsolete twin-engined fleets—especially as their use may become limited by more stringent WAT restrictions in 1959.

Thus although the great Viscount production machine may not long continue at its present peak rate, there are good reasons to expect a continued high rate into the sixties. Certainly there may be fewer major contracts (though there are still European operators like S.A.S., Swissair and Sabena who may yet join the Viscount family). But the effects of (1) shorter delivery date, (2) normal traffic growth, (3) the impact of the 810/840, (4) 700s moving into the DC-3 market and (5) re-equipment of the British independents may all combine to sustain demand.

THE VISCOUNT ORDER-BOOK

Purchaser	No. ordered (to Nov. 11, 1957)			No. delivered (est. at Nov. 15)	
	700	800	810	700	800
Aer Lingus	4	3	—	4	1
Air France	12	—	—	12	—
Black Lion Aviation	—	—	1	—	—
Brazilian Government	2	—	—	1	—
British European Airways	27	40	—	27	24
British Overseas Airways Corp.	3	—	—	—	—
British West Indian Airways	8	—	—	6	—
Butler Air Transport	2	—	—	2	—
Canadian Government	1	—	—	1	—
Capital Airlines	60	—	—	60	—
Central African Airways	5	—	—	5	—
Continental Air Lines	—	—	15	—	—
Cubana	3	—	4	3	—
Eagle Aviation	—	2	—	—	—
Fred Olsen Airtransport	6	—	—	6	—
Hong Kong Airways	2	—	—	2	—
Hughes Tool Company	1	—	—	—	—
Hunting-Clan Air Transport	3	—	—	3	—
Icelandair	2	—	—	2	—
Indian Air Force	2	—	—	2	—
Indian Airlines	10	—	—	4	—
Iranian Government	3	—	—	—	—
Iraqi Airways	4	—	—	4	—
K.L.M.	—	9	—	—	7
Linea Aeropostal Venezolana	3	—	—	3	—
Linee Aeree Italiane	10	—	—	6	—
Lloyd Aereo Colombiano	3	—	—	1	—
Lufthansa	—	—	9	—	—
Middle East Airlines	5	—	—	5	—
Misrair	5	—	—	3	—
New Zealand National Airways	—	3	—	—	—
Niarchos Group	—	—	1	—	—
Pakistan International Airlines	—	—	3	—	—
Pakistan Government	1	—	—	1	—
Philippine Air Lines	2*	—	—	2	—
P.L.U.N.A.	3	—	—	—	—
South African Airways	—	—	7	—	—
South African Government	1	—	—	—	—
Standard Oil Company	1	—	—	1	—
Transair	—	3	—	—	2
Trans-Australia Airlines	14	—	—	12	—
Trans-Canada Air Lines	51	—	—	29	—
Transportes Aereos Portugueses†	—	—	3	—	—
Turkish Air Lines	5	—	—	—	—
Union of Burma Airways	3	—	—	3	—
U.S. Steel Corporation	3	—	—	3	—
V.A.S.P. (Brazil)	—	—	5	—	—
Totals	270	60	48	213	34
	378 Ordered			247 Delivered	

* One leased to T.A.C.A. † Not announced by Vickers.

It is tempting to examine each of these points to see what effect they might have on sales during, say, the next five years.

The effect of shorter delivery date is impossible to gauge quantitively. But it can be argued that the Viscount is now such an established part of the air transport scene that would-be operators no longer regard it as a new piece of equipment which—like other new turbine types—only fits in with long-term plans. It is a turbine aircraft which they can be sure will slip smoothly into service and which they now suddenly find they can have within a year. No estimate of the number of sales resulting from shorter delivery-time is possible: but it might not be rash to suggest that this may sell 20 or 30 in the next five years. Certainly Vickers will lose no opportunity of driving home hard the fact—which has not yet really dawned on the airline industry—that new Viscounts can be had in a year.

Short delivery-time will have its effect on old customers as well as on new; and the potential repeat-order business—a function of traffic growth—may be all the healthier for it. If regional traffic growth continues at only 10 to 15 per cent a year, repeat-orders on the 400 Viscounts which will be in service by mid-1959 would theoretically amount to at least 200 further aircraft by 1962 or 1963. Of course, larger aircraft will by then be taking over some Viscount routes; but again it might not be rash to speculate on at least 100 repeat orders in the next five years.

What of the DC-3 replacement aspect? There are almost exactly 1,500 DC-3s in scheduled airline service, and of these about 300 are operated by 19 purchasers of Viscount 700s. Perhaps a quarter or even a third of them may be replaced by "written-down" Viscounts. The effect of this may not begin to be felt for another two or three years: but the outcome would be a demand for at least another 100 Viscounts.

Britain's independents own 40-odd DC-3s and 30-odd Vikings. There is already a firm trend towards their replacement for scheduled-service and trooping work by Viscounts. The four independents who have so far acquired Viscounts—Airwork, Hunting-Clan, Transair and Eagle—all seem to be able to count on finding them plenty of work, contrary to the expectations of only a year or so ago. It is fair to expect that this tendency will continue, especially as the ageing DC-3s and Vikings will be operating in the face of a trend to bring airworthiness requirements for the older types more into line with modern standards. Perhaps in the next five years we shall see the independents—whose business, and opportunities for business, seem to be gaining steadily—produce a market for 20 or 30 Viscounts.

Finally, the impact of the 810/840—the biggest imponderable of all. Again, there is no firm basis upon which to assess the sales-generating effect of this model on the market. One thing is certain: its effect will be positive, and one feels justified in suggesting that the number of Viscounts which may be sold as a result of the other factors (say 260) may in fact be as high as 300.

Speculation, perhaps, like every market forecast. The prospect of selling 700 Viscounts may indeed seem fanciful to Vickers, who are as prudent and cautious about the future as others who have enjoyed but a fraction of the Weybridge company's commercial success. One imagines that a production machine capable of turning out ten aircraft a month is just as big a worry as one which seems unlikely ever to attain such a rate of output. But an expectation of 700 sales may, as we have tried to show, be a fair estimation of the market-potential of a remarkable aeroplane.

J.M.R.

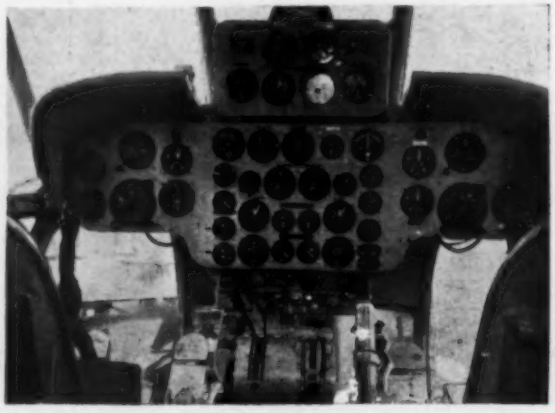
THE ROTODYNE FLIES

ON Wednesday of last week Faireys embarked on the latest stage in the development of their massive Rotodyne "VTO airliner" (see leading article) when Ron Gellatly, senior helicopter test pilot, and John Morton took it into the air for the first time. On the airfield at White Waltham those concerned with the tests are showing a cautious delight. The first four flights, all of them made during the first 30 hours, produced no snags whatever. The Rotodyne had already breezed through its resonance trials and took to the air apparently without the slightest trouble.

Early flight tests were to have explored hovering within the ground cushion, but in fact Gellatly took the Rotodyne for a circuit round the airfield well above ground-cushion altitude during one of the first three flights. On all but the first, too, an observer had been carried; and when *Flight's* representative saw the fourth flight on Thursday of last week, Dr. D. B. Leason, head of the thermodynamics and design group, was acting in this capacity, monitoring the three automatic camera recorders mounted in the forward fuselage. Mr. R. L. Lickley, technical director, Dr. G. S. Hislop, chief designer, and many other members of the design team were present during the early flights.

The Rotodyne was flying at a weight quite close to the 33,000 lb which is the maximum for the development aircraft. Two large blocks of ballast were bolted to the floor close to the rear loading sill. Other test fixtures included two thick jury struts from the main wheels to the inside of the wing root. These are designed to absorb any untoward loads during early landings. The inclined

The long cabin, left, and the pilots' cockpit, below, are neat and airy. Concentration of test instrumentation in the cabin has left the cockpit remarkably orderly for a prototype. The central bank of dials covers engine and control systems and the pedestal is small and tidy.



After the first flight, Ron Gellatly (left), senior helicopter test pilot of Faireys, with his co-pilot John Morton (right) and Mr. G. W. Hall, chairman and managing director of the company.

fins which complete the empennage were also omitted. The cockpit, which is liberally glazed and the roof panels of which are tinted, is finished on the interior in a fresh pale grey from which the black instrument dials stand out extremely well. Gellatly, as captain, is occupying the right-hand seat and all four fixed seats in the aircraft are fitted for seat-type parachutes. Despite a not inconsiderable quantity of test instrumentation covering strain-gauging, systems and aerodynamic performance, the long fuselage is remarkably airy and unencumbered.

For the fourth flight the Rotodyne was "spotted" on a large white patch painted on the ground well out on the airfield, as a reference mark for hovering. The two Elands were started and then everybody withdrew some way as compressed air began to turn the rotor. A dense spray of fuel from each tip preceded the simultaneous lighting of the tip jets and a graceful vertical take-off with the Eland propellers in fully fine pitch. Some time ago Faireys demonstrated the very effective silencers which have been designed for the Rotodyne tip jets; but, since these are not at present fitted, the noise makes White Waltham seem a very small place indeed; the level is formidable—equivalent perhaps to that of a four-engined aircraft at take-off power. This will be very greatly reduced by the silencers and will in any case last only during the short period required for landing and take-off. The Elands themselves are very quiet.

In the air everything seemed to be going smoothly, if cautiously. Gellatly hovered steadily in the strong breeze and control generally seemed to be causing him no difficulty. The control system of the Rotodyne is, of course, completely new and there is no comparable precedent to guide Fairey's pilots and engineers. Though not given to hasty enthusiasm, Gellatly himself was delighted when we spoke to him after the flight. The machine handled surprisingly easily and such tricky adjustments as the automatic co-ordination between collective-pitch control and tip-jet power control seemed to have come out right first time. The machine is, of course, being flown completely untethered.

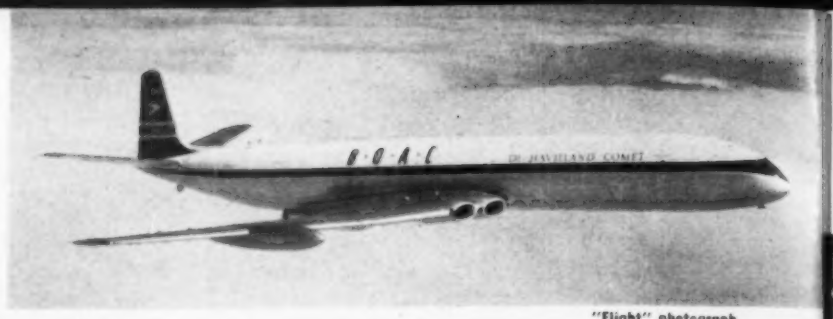
And so, with a feeling of controlled elation, Faireys are continuing to explore the handling characteristics of this revolutionary aircraft.

(*A detailed description of the Rotodyne, with cut-away drawing, appeared in "Flight" for August 9 this year.*)

Dr. G. S. Hislop, chief designer, and Ron Gellatly congratulate each other after the first flight. Looking on (l. to r.) are Gordon Slade, superintendent of flying, Mr. R. L. Lickley, technical director, John Morton, co-pilot, Mr. J. Hillard, experimental flight manager, and Peter Twiss, chief test pilot. Also present, but not seen here, was Mr. F. H. Parker, engineering manager.

COMET 4C

More Payload on Medium Stages



The heading picture shows the Comet 3, development-prototype of the Comet 4 family.

"Flight" photograph

THE adaptability of the Comet 4 breed to changing market trends since the design for B.O.A.C. was announced in 1955 has been quite surprising. With no increase in power (a commodity which de Havilland's jet airliner has always enjoyed in ample measure) the strain has been so developed that we see today the 4C offering a ton more maximum payload than the 4. Obviously this has not been achieved without some penalty in range; but the 4C appears to be the deliberate outcome of applying the 4's ample power to lifting payload rather than fuel.

This has been in direct response to the changing circumstances of the market. When the original Comet 4 design was settled the revolution of long-range travel had yet to be brought about by the Boeing 707 and the DC-8. At that time, in the early months of 1955, the emphasis in Comet 4 design was upon maximum range: even North Atlantic range was felt to be worth striving for. But the big American jets caused a change of emphasis, and thenceforth efforts were directed to improving the Comet for the medium-range rôle.

The 4A pointed the way (in July 1956) towards refinements in structure and drag (and increases in payload capacity) which led last September to the Comet 4B, the member of the family now aimed at the short-to-medium-haul operators. This aircraft in turn pointed the way to the lower seat-mile costs which result from the increased capacity of the lengthened fuselage—now logically conjoined with the original Comet 4 full-span wing to endow the 4C with maximum medium-haul economy.

The 4C, as will be seen from the table, does not have the maximum 3,000-mile stage-length potential of the 4, which remains the longer-haul member of the family. The Comet 4 continues to be aimed at operators who want a jet for long intercontinental trunk routes, but who do not feel justified in buying the big traffic capacity of the DC-8 and 707.

The table summarizes the salient points of each version. It will be noted that the Comet 4 itself has been considerably developed: its gross weight has now been raised from 152,500 lb to 156,000 lb (the same as that of the 4C); and particularly interesting is the way the 4's zero fuel weight—the factor which sets the structural (wing bending) limit upon payload—has been raised from its original 92,000 lb to 95,000 lb. Surprisingly, although it has the same wing, the 4C has an even higher z.f. weight than the 4.

Although the 0.74 Mach of the Comet 4C remains the same as for the 4 and 4B, structural considerations resulting from the increased payload and fuselage weight of the 4C make it necessary to reduce slightly the normal limiting I.A.S. This affects T.A.S. (i.e., block speed) only when the aircraft is operated below 33,000ft (the 4C's maximum-speed height), because at lower altitudes the maximum operating speed is dictated by I.A.S. and not by Mach number. On the longer stages, however, block time will rarely be reduced.

The payload range capabilities of the three types are shown in the graph, which includes fuel reserves as follows: ¾ hr holding at 15,000ft at destination; 220 n.m. diversion from 1,000ft; 5 min approach-fuel at destination; 1,000 lb final reserve fuel; and 4½ per cent *en route* fuel.

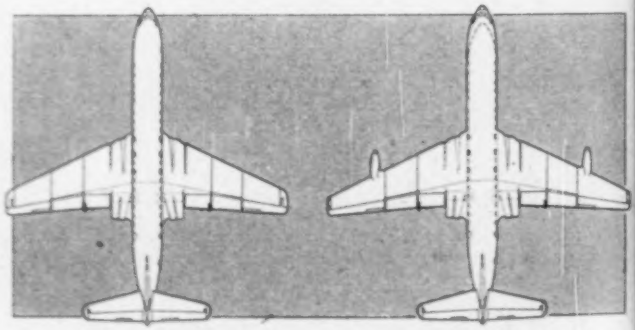
Take-off and landing performance of the 4C will hardly differ from that of the Comet 4, at the same weight. For example, at 156,000 lb, take-off field length in sea level standard conditions will be 6,770ft, rising to 9,500ft at 4,000ft-high aerodromes in I.S.A. plus 5 deg C. Similarly, landing-field length, to the proposed new British requirements and at maximum landing weight, will be 6,820ft at sea level in I.S.A. plus 17½ deg C conditions.

Direct operating costs of the 4B and 4C will be practically identical. The de Havilland company say that the 4C can be used "over the short stages of the Comet 4B's natural field of operation without any penalty in operating economics," adding that "a small increase in block time consequent upon its slightly lower I.A.S. limit will be no handicap except perhaps in those parts of the world where speed and extreme flexibility, which are the special attributes of the Comet 4B, are of paramount importance."

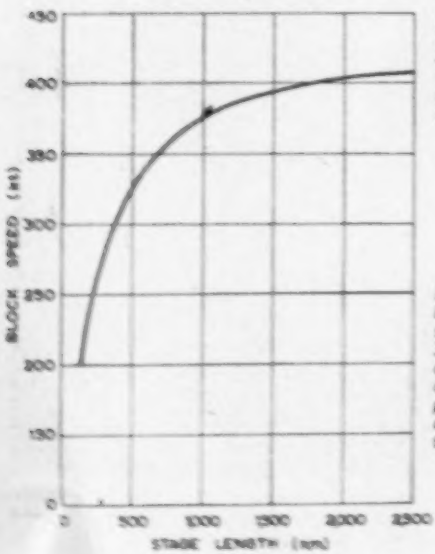
THE COMET FAMILY

Loading Particulars	Comet 4	Comet 4B	Comet 4C
Overall length, ft	111.5	118	118
Span, ft	115	107.8	115
Height to top of fin, ft	28.5	28.5	28.5
Wing area, sq ft	2,121	2,059	2,121
Maximum gross weight, lb	156,000	152,500	156,000
Maximum landing weight, lb	113,000	118,500	118,500
Maximum zero fuel weight, lb	95,000	102,500	102,500
Usable fuel capacity, Imp gal	8,990	7,890	8,990
Maximum stage length with capacity payload, st.m.	3,000	2,300*	2,475
Corresponding capacity payload, lb	16,800	21,968	21,785
Typical first-class seating capacity	60	84	84
Maximum tourist-class seating capacity	76	99	99

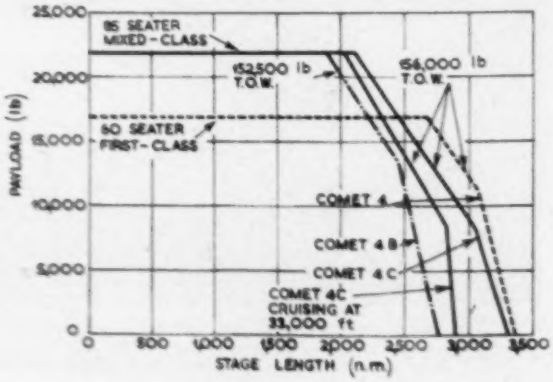
* Using long-range cruising procedure.



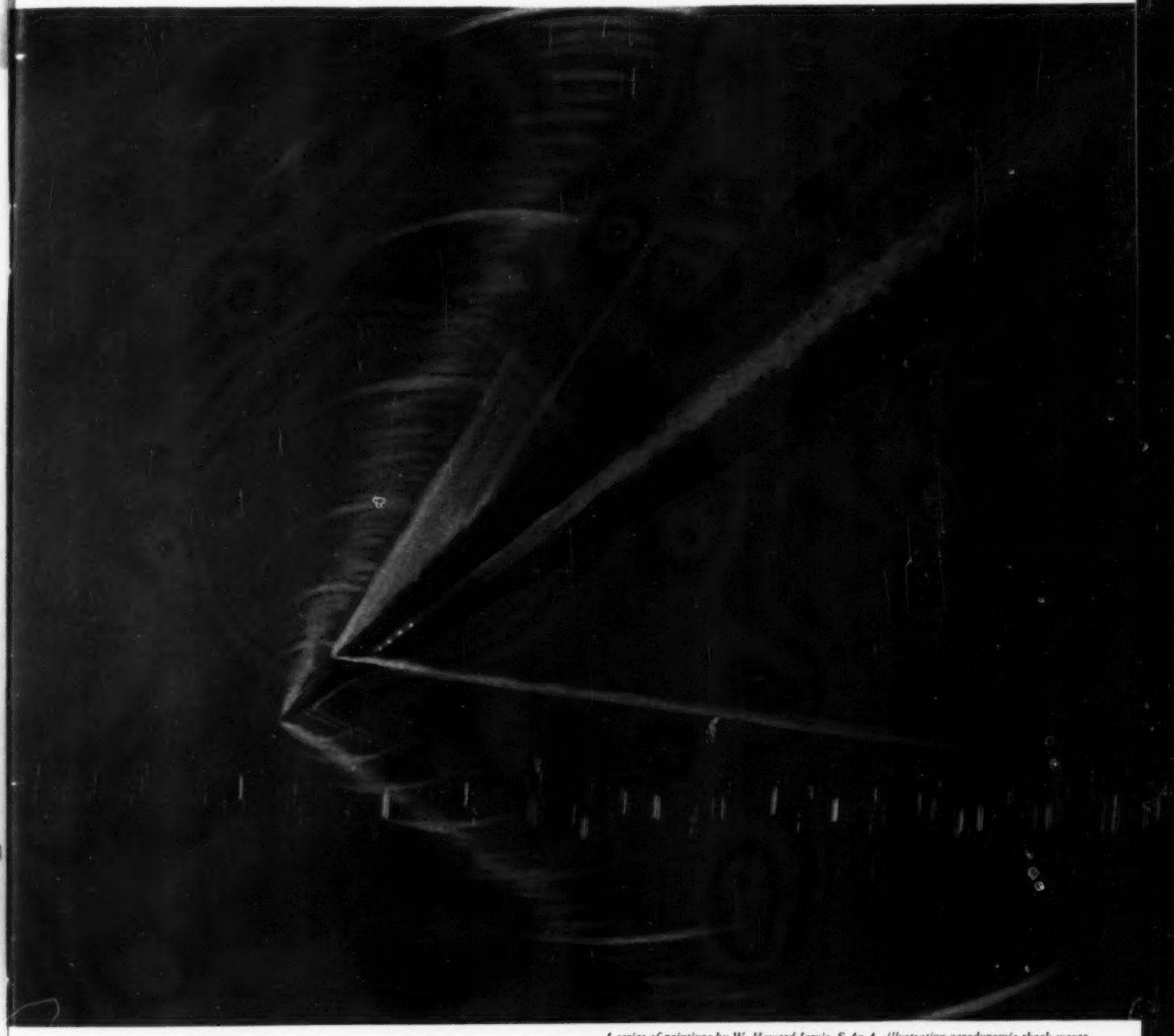
Right, a comparison of the 4B (left) and 4C. The 4 resembles the 4C except in fuselage length, shown by the dotted nose line.



Left, Comet 4C block speed ("high-speed cruise") at 33,000ft; I.S.A. + 10 deg C; 15 min terminal time. Right, payload-range. (For assumptions see text, column two.)



DE HAVILLAND ENGINE RESEARCH SPEEDS THE WAY AHEAD



A series of paintings by W. Howard Jarvis, S.Av.A., illustrating aerodynamic shock-waves.

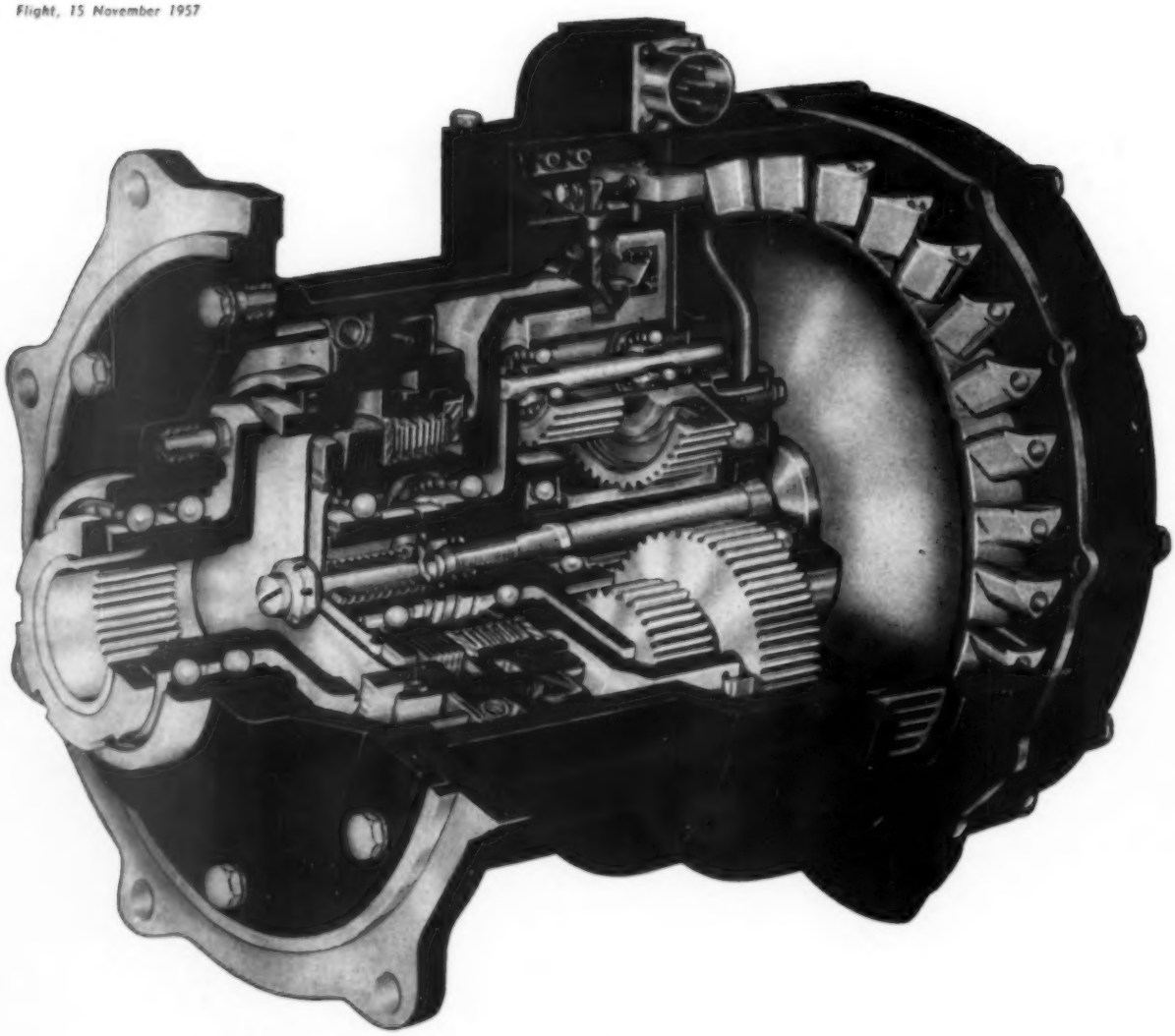
No. 6

M=3·2

The wedge-type shock pattern from the wings and the bow-wave forming a distinct Mach cone are clearly visible in this study of flight at more than 3 times the speed of sound. At this velocity the problem of aerodynamic heating — faced by aerodynamicist and metallurgist alike — assumes very large proportions.

DH ENGINES

GYRON GYRON JUNIOR SPECTRE



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The Sopwith Tabloid, Schneider and Baby

HISTORIC MILITARY AIRCRAFT No. 17 PART II

By J. M. BRUCE, M.A.

SOON after the outbreak of war the Admiralty realized that high-speed, single-seat seaplanes could serve a useful purpose with fleet units and at coastal stations. In November 1914, the Sopwith company received an order for 12 aircraft similar to the seaplane version of the Tabloid which had won the Schneider Trophy six months earlier.

These machines were numbered 1436-1447 and were delivered early in 1915. They were closely followed by a batch of 24 (1556-1579) and a further 100 (3707-3806).

In the official history and in several other documents the production machines are referred to as Sopwith Schneider Cup seaplanes—a designation which was not only cumbersome but in one sense inaccurate, for the Schneider Trophy is not a cup. Popular usage soon abbreviated the designation to Sopwith Schneider, and the aircraft will be so described in this narrative.

In appearance, the production Schneiders looked very like Pixton's machine. The only immediate obvious modification lay in the undercarriage: it was taller and incorporated N-struts between fuselage and floats, and the tail-float was braced away from the fuselage whereas on the original Tabloid seaplane it had been attached directly to the lower longerons. But there were other differences, the most notable of which was the divisible fuselage. This was made in two portions which met at a distance of one bay behind the back of the pilot's seat; the principle was identical to that used in the later Sopwith 2F.1 Camel. The actual connections, one at each longeron, were made by clips which appeared to be a form of turnbuckle. Obviously the Sopwith Schneider was intended for service from seaplane carriers, and the divisible fuselage was used to conserve stowage space. Nevertheless, no references have yet been found which indicate that Schneider rear fuselages were in fact detached on board ship: probably the small overall dimensions of the aircraft rendered such action unnecessary, and certainly the machines could not have been quickly brought into action if they had to be partly assembled before flight.

On the earliest Schneiders, the warping wings and triangular fin of the prototype (if such it can be called) were retained, but the production machines had new tailplanes of broader chord and shorter span, and the total area of the vertical tail was slightly increased. A Lewis gun was usually mounted in a slot in the centre section and fired forward and upwards over the propeller; some Schneiders had their guns mounted more nearly vertically, however.

Each float was 10ft 2in long, 1ft 9in in beam, and weighed 72 lb; its displacement was 1,250 lb. These floats were wooden pontoons: the timbers were ¼in square, spaced 6in apart; sides and top were of ¼in three-ply, and the bottoms were also of plywood $\frac{3}{16}$in or ¼in thick.

The production Schneiders became available early in 1915. While the third batch was going through the Sopwith shops the first modifications to the design were introduced: ailerons on upper and lower mainplanes replaced the warping control of the first Schneiders and the wing cellule was braced as a rigid structure; the area of the fin was increased, the new surface having a humped leading edge which gave the tail unit a characteristic appearance. It is not known which Schneider was the first to have these modifications, but there is photographic evidence to show that No. 3804 had ailerons and the new fin.

One of the modified Schneiders was fitted with experimental main floats. Designed by Lt-Cdr. Linton Hope, these were constructed in similar fashion to the excellent flying-boat hulls designed by that officer. Wooden planking was applied to a structure of wooden hoops and stringers to produce a body which was light, strong and of better streamline form than the standard pontoon-type float. In the case of the experimental Schneider, the planing bottom of each float sloped outwards from the aircraft centre line. (This feature was repeated in the pontoon floats of the later Port Victoria P.V.5.) The Linton Hope floats added 8 m.p.h. to the experimental Schneider's maximum speed, but the pontoon floats remained standard.

INFORMATION supplied by Mr. Bruce Robertson and material lent by Mr. A. R. Weyl, A.F.R.Ae.S., A.F.I.A.S., F.B.I.S., has contributed substantially to this history, and the author wishes gratefully to acknowledge their assistance.

Aircraft production was a comparatively simple business at the beginning of the war. Although the first order for Schneiders was not placed until November 1914, the first production machine, No. 1436, was reported at Calshot in February 1915. No. 1437 was sent to the Eastern Mediterranean in the following month and may well have been one of the two Schneiders which, as noted earlier, were taken on board *Ark Royal* at Mudros on April 8, 1915, in exchange for her two useless Tabloids.

At the end of April, one of *Ark Royal's* Schneiders was transferred to the light cruiser *Doris* as a replacement for the Sopwith 807 which had earlier been lent by the carrier. The 807 had made a number of useful reconnaissance flights, but the firing of *Doris'* after 6in guns had strained the airframe and stripped the fabric from the fuselage. After taking on her Schneider, *Doris* went south, and the little single-seater reconnoitred Smyrna several times with important results.

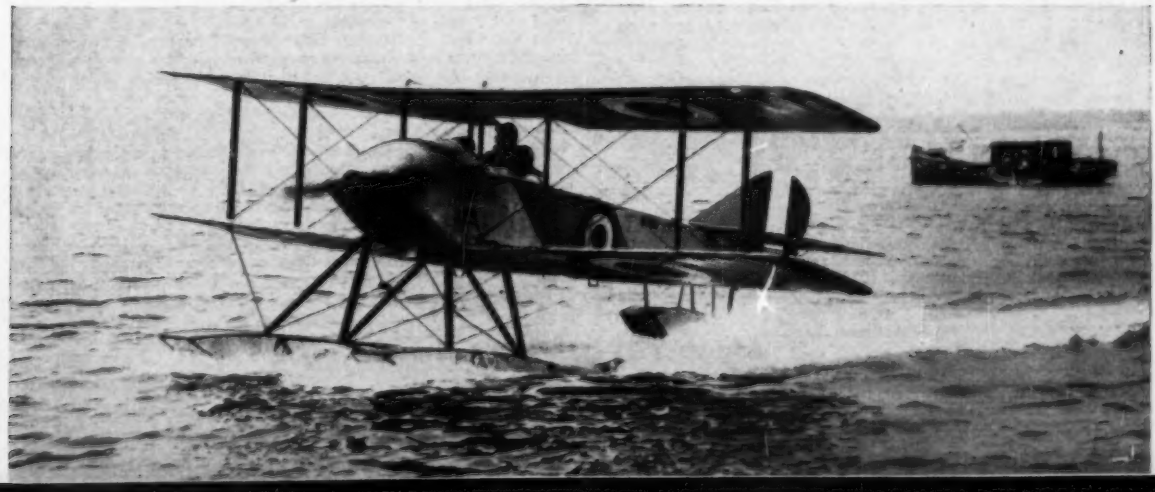
In home waters, Schneiders were sent to R.N.A.S. coastal stations and were extensively used from a variety of ships. In the early months of their service, the little Sopwith seaplanes were regarded as potential Zeppelin destroyers, for they could be readily taken to sea and had a good turn of speed. From the coastal stations the Schneiders could likewise be got away reasonably quickly and were more likely to get to grips with enemy airships than the contemporary Sopwith Two-seater Scouts which rejoiced in the nickname "Spinning Jenny."

But success eluded the Schneiders from the beginning. In the spring of 1915 several attempts were made to bomb the enemy wireless station at Norddeich and to reconnoitre Norden, where an airship base was believed to be situated. Seaplanes were taken to sea in the light cruisers *Arethusa* and *Aurora* and in the seaplane carriers *Empress*, *Ben-my-Chree*, *Engadine* and *Riviera*, but adverse weather thwarted the enterprise four times. On May 11, 1915, *Ben-my-Chree*, *Engadine* and *Riviera* set out again, escorted by the Harwich Force of light cruisers and destroyers. As the ships neared the German coast a Zeppelin was sighted. Immediately *Ben-my-Chree* tried to get one of her Schneiders airborne by putting its floats on wheels and flying it off the sketchy forward platform. No doubt the whole gallant idea was makeshift and hastily executed, and the attempt failed when the launching gear was wrecked by the engine backfiring.

Nor was the raid successful, and the Harwich-based force of seaplane carriers was dispersed: *Engadine* went to the Firth of Forth to join the Battle Cruiser Fleet, *Riviera* went to Dover, and *Ben-my-Chree* to the Mediterranean.

British naval units patrolling the North Sea continued to come under the attention of Zeppelins, and in an endeavour to hamper the activities of the airships, Schneiders of Felixstowe Air Station were put on board some of the light cruisers. On June 2, 1915, *Arethusa* sent off her Schneider to pursue a Zeppelin which had appeared. The seaplane succeeded in taking off but, at a height

A production Schneider seaplane—an early version with warping wings and original small fin.



Left, a Schneider with Linton Hope floats. Right, a production Schneider with ailerons and enlarged fin.

The Sopwith Tabloid, Schneider and Baby . . .

of only 1,800ft, the pilot mistook the smoke of *Arethusa's* attendant destroyers for the smoke-screen which was to be his recall signal. He returned to *Arethusa* and the Zeppelin flew on unchallenged.

Just over a month later, on July 4, the seaplane carriers *Engadine* and *Riviera* participated in the operations which had as one of their objects the reconnaissance of the Ems river and Borkum area. The second purpose of the mission was to bring the Zeppelins to action. Zeppelins there were in plenty, for no fewer than four came to watch the British naval force; moreover, the weather was well-nigh perfect. Three Sopwith Schneiders, fresh from the makers, were hoisted out from *Engadine*. History does not record the precise reason why the floats of all three broke up when the Schneiders took the water, but break up they did. Two of the aircraft sank ignominiously, but the third was salved. Fortunately, all the pilots were saved. Unfortunately, so were the Zeppelins.

Such occurrences—for float failures were not peculiar to Schneiders—seemed only to justify the sceptical attitude maintained by more than one senior naval officer towards the value of aircraft. Yet in the remarkable *Revenge* trials of April 7 and 8, 1915, the value of aircraft as gunnery observation posts had been indisputably established. The reports were sent to Admiral Sir John Jellicoe on July 23; he agreed that air spotting had been proved to be a valuable aid to gunnery. He went on to say, however, that experience with the seaplanes carried aboard H.M.S. *Campania* indicated that such aircraft would seldom be able to operate from the open sea. It was his opinion that the only type likely to be consistently successful was one which could be flown from the seaplane carrier's flying-off deck and brought down on the water at the end of its flight, relying on air-bags for flotation until the pilot could be picked up. Jellicoe pointed out that our need for air spotting was made more urgent by Germany's possession of that facility, thanks to her naval airships.

At that time, apart from the pre-war shipboard flights by Eugene Ely in America and Cdr. Samson in England, the only recorded attempt at a take-off from a ship at sea was the abortive effort made by a Schneider on *Ben-my-Chree* on May 11, 1915. *Campania* was better equipped than the *Ben*, for she had a 120-ft flying deck built above her forecastle. A former Cunarder built in 1893, she had been bought for conversion to a seaplane carrier as a result of a suggestion (made by Capt. Murray Sueter when the war was but ten days old) that a large liner fast enough to keep station with the Grand Fleet be fitted out to carry eight to 12 seaplanes. Reconstructed by Cammell Laird, *Campania* was commissioned on April 17, 1915, and forthwith began experimental work at Scapa Flow. Exercises in June served only to demonstrate the extreme difficulty of hoisting out seaplanes in a rolling sea, and the fragility of their floats when once they had been deposited on the water.

With these experiences in mind, the men of *Campania* needed no urging to act upon Sir John Jellicoe's suggestion, and on August 6, 1915, a Sopwith Schneider was flown off the carrier's deck by F/L. W. L. Welsh. The ship was steaming into wind at 17 kt, and the Schneider's floats rested on wheels which were dropped into the sea at the end of the take-off run, which was 113ft. The take-off showed what could be done, but obviously a longer deck would be required if heavier aircraft were to take off successfully. *Campania* was subsequently modified extensively to provide a flight deck of 210ft, and rejoined the Grand Fleet at Scapa Flow on April 12, 1916.

Regular anti-Zeppelin patrols were flown by seaplanes, which could only have been Schneiders or their descendants, carried by armed steam trawlers. The first trawler to be given a seaplane was H.M.S. *Kingfisher*, in May 1915. In his book *The Story of a North Sea Air Station* (page 126), C. F. Snowden Gamble sadly records:

"Although seaplanes were sent off from this trawler and her sister ships on almost every calm night during 1915, 1916 and 1917, the pilot of no such machine ever sighted a Zeppelin airship, although during this time a large number of raids were made on England by airships which must have crossed close to the patrolling seaplanes."

To get fighting seaplanes across our own defensive minefields the Admiralty, in March 1916, equipped two paddle steamers, the *Killingholme* and *Brocklesby*, to carry two or three Sopwith Schneiders. Despite the greater combat area this opened up, the Schneiders still found no Zeppelins.

The Harwich command even experimented with submarine-borne seaplanes in April and May 1916, when Schneiders were taken to sea aboard the *E.22*. The aircraft were launched successfully and flew back to Felixstowe. But although successful, these experiments were not developed, owing to the impossibility at that time of making a suitable housing for the seaplane without adversely affecting the submarine's submerging capability.

H.M.S. *Ben-my-Chree* (Sqn. Cdr. C. J. L'Estrange Malone) arrived at Iero Bay, Mitylene, in the Aegean, on June 12, 1915, carrying three Short 184s and two Sopwith Schneiders. Her aircraft, especially the Shorts, performed gallantly in support of the Dardanelles campaign. So too had Cdr. C. R. Samson who, as noted above, commanded No. 3 Aeroplane Wing, R.N.A.S., from March to December 1915. After the evacuation of the Gallipoli Peninsula, Samson returned home on leave, but *Ben-my-Chree* was transferred to Port Said, where she came under the operational control of the Commander-in-Chief, East Indies. There she joined the seaplane carrier *Empress* and the former tramp steamers *Anne* and *Raven II*, which had been fitted to carry two seaplanes each. *Empress's* complement was two Short 184s and four Sopwith Schneiders; *Anne* carried one Short and one Sopwith; and *Raven* ultimately operated with two Shorts and two Sopwiths. These ships, their companies and aircraft together constituted the East Indies and Egypt Seaplane Squadron. In April 1916, *Empress* was temporarily transferred to Mudros for operations in the Eastern Mediterranean.

In the following month the squadron came under the command of W/C. C. R. Samson. He took over the captaincy of the *Ben-my-Chree* from Sqn. Cdr. L'Estrange Malone, who became second-in-command of the squadron and captain of H.M.S. *Raven II*. Samson lost no time in re-acquainting himself with the handling of seaplanes by flying both Shorts and Schneiders.

Samson's philosophy of war was predominantly offensive, and his seaplane squadron must have been a painful but elusive thorn in the flesh of the Turks in that theatre of war. The Schneiders responded nobly—bombing, ground-strafing and even spotting for the guns of warships. In this last activity, corrections were signalled by Very pistol, a cumbersome procedure. In their bombing exploits, the Schneiders could carry five 20-lb bombs, which were occasionally (as at Waht and Subar on June 8, 1916) delivered from an altitude of 500ft.

The pilots of the *Ben-my-Chree* Schneiders were usually Lt. Wright and Flt. Sub-Lt. Bankes-Price, but in the afternoon of June 9, Samson himself "took a Sopwith and killed a number of Turks near Darb." On June 15, Bankes-Price, flying a Schneider, attacked Turkish trenches on the south of Jeddah, dropping his 65-lb bomb from only 100ft and then firing all his Lewis gun ammunition into the enemy's positions. This gallant and skilful young officer lost his life on September 16 when his Schneider was shot down in flames near El Arish by an enemy aeroplane which attacked the Short 184 that he and Flt. Sub-Lt. Nightingale were escorting. Nightingale fought unavailingly and was forced down with his petrol tank holed; it was left to the Short to put the enemy to flight.

Ben-my-Chree's Schneiders were by no means new, as Cdr. Samson found on September 14, 1916. He had flown one as an escort to a Short 184 and experienced increasing vibration on his return journey. After alighting, his Schneider's engine fell out of its bearers, and it was discovered that the heat and constant use had proved too much for the structure, for the forward longerons were rotten. Fortunately, better replacements had begun to come forward, since (writing of the events of late July 1916) Samson recorded: "Some new Sopwiths arrived about this time. As they had 110 h.p. Clergets in place of the 100 h.p. Gnôme, they had a better performance."

(*To be continued*)

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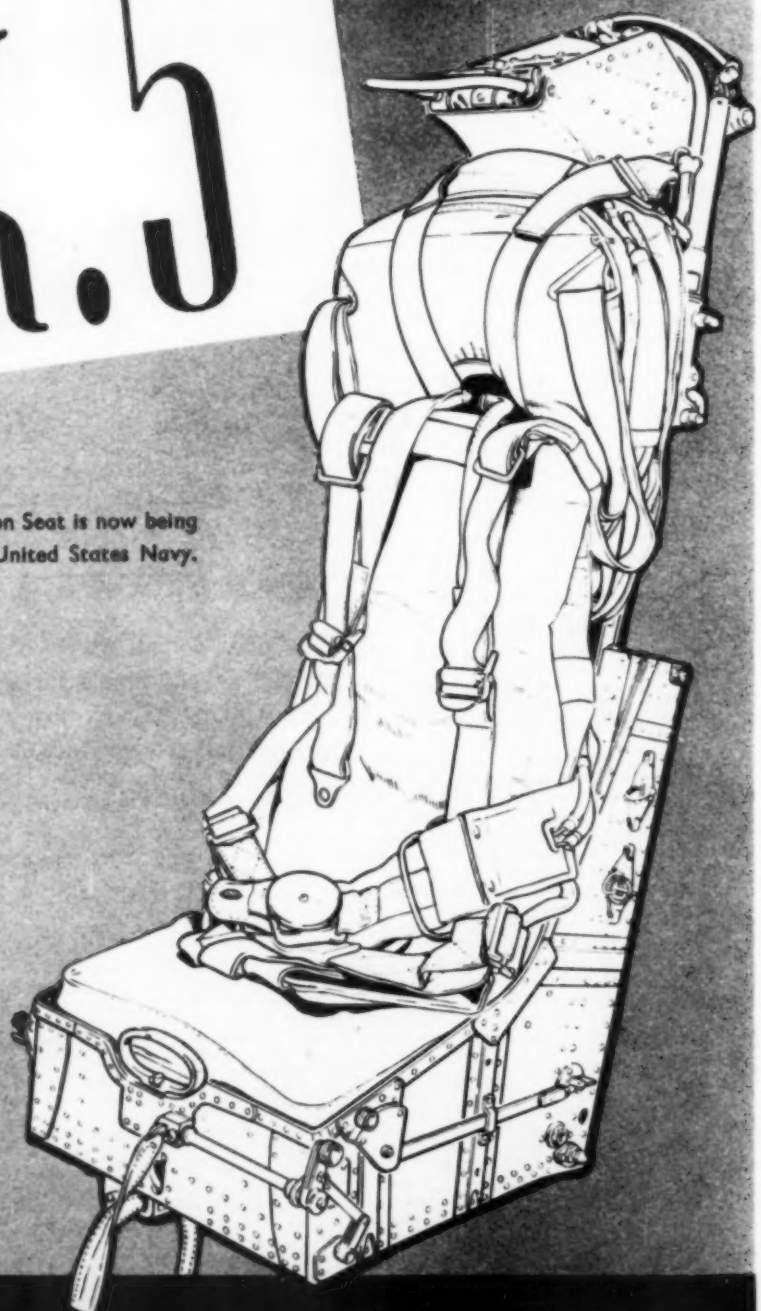

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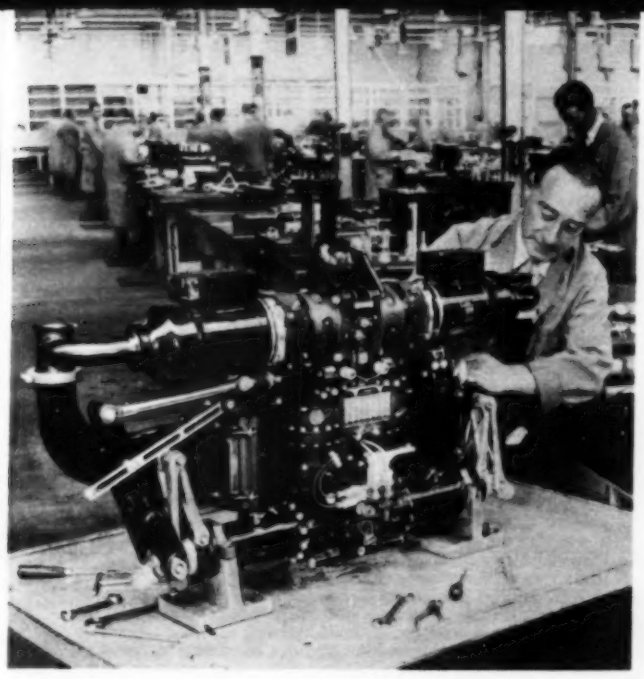


Precision work at Hobsons. This is the final assembly stage of a duplicated and self-contained powered flying control for a bomber. Cooling ducts surround the electric motors and hydraulic reservoirs.

Control Systems Outlook

Some Thoughts on Tomorrow

"THE White Paper on Defence," an acquaintance remarked recently, "is becoming rather a bore." He meant, of course, that discussion of its implications had largely degenerated into repetition and that most worthwhile comment had already been made; the only remaining arbiter of the Paper's wisdom, he felt, was that of time. However this may be, for most firms within the aircraft industry 1957 will have been a year of crucial policy-reshaping; and only in these closing months, when the impact of the changes to be made had been absorbed, can a clearer idea be gained of the way the industry has turned to meet the challenge. The word "challenge" is used advisedly, since although most firms foresee periods of stiff competition ahead, promising alternative markets are being explored, and many of the special talents and skills that have been developed for military needs will become available to a wider field than hitherto. Civil aircraft, in particular, should benefit from the re-channelling of design effort and from an unprecedented selection of improved component and system designs when tried equipment must be replaced.

The components industry, which has steadily been increasing its stature in recent years, is at least as deeply affected by new Government policies for the aircraft industry as are the manufacturers of engines or airframes, and they would be justified in viewing with concern, as well as determination, the prospect for the years ahead. Recently *Flight* visited H. M. Hobson, Ltd., and their associate Integral, Ltd., of Wolverhampton, to discuss with them their reactions to the upheavals of the past few months and their thoughts on the design of systems for the aircraft, engines and missiles that will form the pattern of equipment a few years hence.

Situated on the northernmost fringe of Wolverhampton, Hobson's works employ about 2,400 people. Fronted by lawns, the factory is modern, spacious and—even for these enlightened days—maintained at an unusually painstaking standard of cleanliness. Production and design departments are geared to precision engineering of a very high standard (at least as high as that of any other organization in the country) and the policy of the firm is directly conditioned by this ability to continue to manufacture high-precision equipment. For several years to come, Hobsons will be heavily engaged in working-off their present substantial backlog of orders; and in the overhaul of equipment now in service (the business from this work on injection carburetters—production of which is tailing-off—is still considerable).

Demands on the design and production organizations remain heavy, for very few of the projects upon which the company were engaged at the turn of the year were cancelled when the White Paper was published. Hobson powered flying controls (self-contained units embody the Integral pumps of the associate company), feel-simulator units, autopilot servos, flap-operating mechanisms, fuel systems, Integral fuel flowmeters and a comprehensive range of pumps and so on—these equip at least 13 British aircraft and several engines, and associated equipment is used on a number of missiles and in other miscellaneous applications.

With their interests thus widely deployed, Hobsons can look at their future market with an eye unjaundiced by present hunger. There is not (they admit) going to continue to be work for them—or for anybody else in the precision component industry—on this scale; this is an unpleasant but immutable fact. There may well be another generation of British supersonic military aircraft (a belief that is currently finding a good deal of support within the industry) but, apart from various items of equipment for aircraft programmes that survived curtailment, the firm will concentrate on civil aircraft and civil engines and on the development of the type of servo equipment that could be used (for example) in VTOL aircraft control.

Some time ago, as a development of their control-system activities, Hobson accepted work from the Atomic Energy Commission on the design and manufacture of control gear. Although much of the equipment was larger than most of the components that the firm was accustomed to manufacture, this did not in any way imply a compromise of the company's standards of precision engineering; rather the reverse, since atomic development work has frequently demanded laboratory standards of accuracy or tolerance on a semi-production basis. This "atomic" side of the firm's activities, although no longer directly connected with aircraft work, is regarded by those directly concerned with the supply of equipment to the aircraft industry as being of considerable long-term importance, since the possibilities that the two will be conjoined (see, for instance, *Flight*, October 18, p. 631) no longer appears too remote a possibility for more than passing consideration.

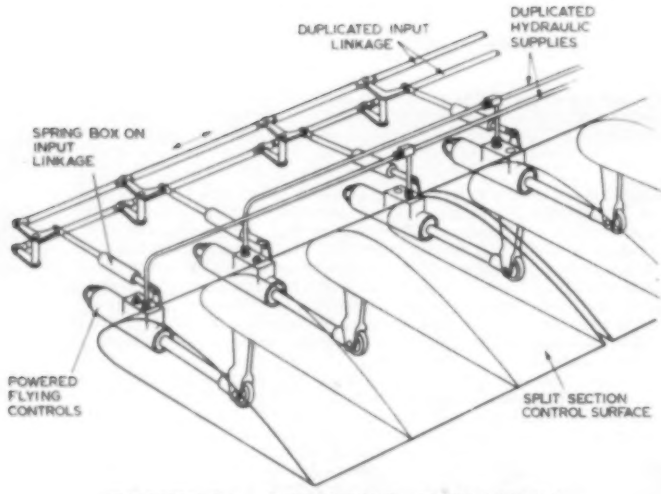
Present shorter-term planning, nevertheless, is concerned with the mainstay of production a few years hence, and it is our intention in this article to discuss the way that one manufacturer—within the confines of normal commercial security—sees the development of systems for civil aircraft of the coming generation.

In general terms, it is possible to comment on some of the difficulties with which all manufacturers in the components industry are faced. Foremost, perhaps, is the natural reluctance of any aircraft operator to experiment with untried equipment until he is forced to do so by sheer operational necessity; development costs money and may be responsible for delays to services. The obvious corollary that the component manufacturer must develop his own product if he hopes to sell it is valid to only a limited extent, since the amount of proving that can be done in three months of airline operation exceeds by far the amount of bench testing that a manufacturer could do in several years. The problem of development is a very real one, and eventually both sides of the industry may look to the Ministries or to the Society of British Aircraft Constructors for the development assistance that will be needed if design is not to stagnate.

In particular, aircraft manufacturers and operators can be expected to become selective in the matter of equipment overhaul periods; as "prime contractor" the responsibility for all aircraft systems is that of the aircraft manufacturer; and the choice, the reliability, and the life of proprietary components is as much a part of the design of the aircraft as decisions affecting the structural envelope.

Flying controls. After some ten years of development, the design of powered flying controls—an important sphere of Hobson's activities—has attained a level of stability. Designs embodying a screw-jack as the output member have largely been replaced by the lighter and simpler piston jack, since experience has shown that, provided there is a reasonable base hydraulic pressure within the jack, this type will be stiff enough to constitute a safeguard against the onset of flutter, since the jack is inherently less elastic than the surrounding structure. Even the loss of "dynamic stiffness" when the control is operating under conditions of load or velocity saturation appears relatively insignificant. For military aircraft, the usual arrangement of Hobson powered flying controls is a single tandem jack on each surface with the jack body employed as a common output; a duplicated hydraulic supply (in some cases a duplicated self-contained hydraulic system), and a single input linkage to paired servo valves. This arrangement is simple, and economical in installed space and weight.

The technique of negative feedback is employed on the mechanical linkage. This simply means that the inevitable distortions of the structure relative to the input linkage are arranged to be reflected at the flying-control valve in a manner that cancels out



Shown schematically is a possible flying-control system for civil aircraft, with two powered controls to each section of a divided control surface. Return hydraulic lines and jack-position feedback linkage have been omitted. Spring boxes protect the linkage from valve seizure.

CONTROL SYSTEMS OUTLOOK . . .

spurious signals—a damping rather than an exciting tendency. A "reversing lever" adjacent to the flying control valve is a simple way of ensuring the negative feedback effect.

Hobson work on flying controls for military aircraft has led to the development of electrical signalling between the stick and the powered control, since modern military aircraft are in any case making extensive use of electric and electronic control in the flight system and weapons control of the aircraft. There are also substantial advantages to be gained in the problems of control at high induced temperatures. The work of Hobson and other firms in this field has been discussed in the issues of *Flight* reviewing the Farnborough Show. The appearance of such a system in a production British aircraft has now probably been delayed by some years, but it is worth noting that an aircraft equipped with full electrical signalling of all its powered flying controls ("fly-by-wire" system) is shortly to fly in North America. A system utilizing Boulton Paul flying controls and limited to the aileron channel has been flown in the U.K. in the Tay-Viscount.

This does not mean, however, that the lead in this branch of flying control science has been surrendered. Contracts for the development of electrical signalling by flight experience have been continued, and Hobson now have a "half-way" electrically signalled system flying in an Air Survey, Ltd., Dakota operating from White Waltham. Although coupled to the stick, the output of the system does no work on the flying-control surfaces; the system is merely operated in a representative way. A second and more advanced system is shortly to be installed and flown for 1,000 hr.

A word about the development of the system itself is appropriate here, because it underlines Hobson's feelings about the provision of safeguards. The first system with Elliott amplifiers and A.C. pick-offs (exhibited at the 1956 S.B.A.C. Show) had as a stand-by signalling circuit a mechanical linkage that was clutched-in if a failure occurred in the electrical line. Although it operated quite satisfactorily on the bench this conception was really in opposition to the general Hobson philosophy, since change-over from an electric main system to a manual stand-by is difficult to achieve and is complicated by the necessity for fault-sensing devices. There are also likely to be various difficulties in aligning the electric and mechanical channels during installation. But the crux of the problem is that the mechanical channel must be made the reference against which the electrics are checked, and this suffers from every one of the disadvantages which the electric signalling is put there to avoid; the worst of both worlds, in fact.

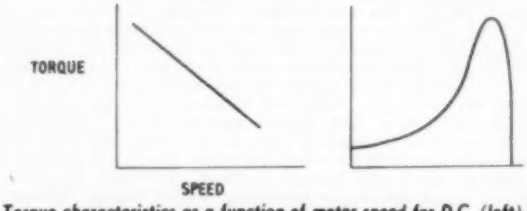
The succeeding system was consequently all-electric, using Hobson thermionic-valve amplifiers and triplicated signalling channels, pick-offs, torque motors and valves. The need for triplication is governed by the need to control the three conditions of an electrical signal: it can be off, it can be on, or it can provide the wrong information. Should a signalling error occur on one channel, the system will then be majority-ruled and continue to work satisfactorily. The American approach, incidentally, appears to be to use a multiplicity of pick-offs and signalling channels but to mix the signals in one amplifier and use one relay and one valve. And although for reliability multi-channel signalling is used, mechanical stand-by is retained.

In November 1956 Hobsons and the A. V. Roe weapons division stated liaison on the developed electrical signalling system which is soon to be installed in the test Dakota, and the two organizations are now working in close conjunction.

Whether, in the light of changed emphasis, this particular control-system development will proceed much further is difficult to foresee. It depends largely on whether British aircraft with a very high performance (in the terms of two or three years hence) and comprehensive electric and electronic systems are ever built. Although certain advantages for civil transports can be also shown, it is most unlikely that such control systems would ever come into the civil field without the usual military evolutionary process. But if this did occur, the widespread experience gained would eventually result in natural civil acceptance. In time-scale, this might coincide with the advent of the supersonic airliner.

Powered flying-control design for civil aircraft is developing, in Hobson's view, along fairly well-defined lines. The requirements of A.R.B. and (in particular) C.A.A. demand coverage of a wider range of failures than need be met in military applications, and the trend of design is governed by meeting each of these cases with the simplest overall system. Among the conditions to be considered are those governing a runaway servo, disconnection of the input linkage, and fracture of any critical element in the system. The C.A.A. also demand that if the input circuit is not duplicated, the trim system must have sufficient authority to ensure that a safe landing can be made in the event of disconnection of the normal control system.

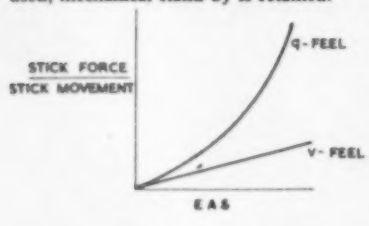
Resolution of these stipulations tends to lead to the system illustrated at top left. To cater for a disconnection or runaway failure (it is worth noting that, in Hobson's experience, no such case has ever occurred) the control surfaces are split, so that the failure of one section of a surface can be over-ruled by the remaining, active sections. The number of divisions will depend upon the handling of the aircraft with one section inoperative.



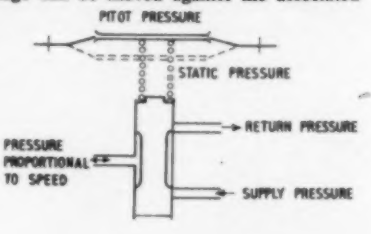
Torque characteristics as a function of motor speed for D.C. (left) and A.C. (right) machines. The advantages of A.C. starting in spite of this apparent handicap are discussed in the text.

In practice, the difficulties of providing such a trim system with powered controls is such that it is usually simpler to duplicate the input circuit, and this is carried up to the input to the servo valves. The number of jacks used on each section is determined by the necessity for retaining stiffness of the surface should the output of one jack become disconnected, or seal failure cause a complete loss of fluid. There are, consequently, separate hydraulic supplies from engine-driven pumps to each jack of a pair. The less acceptable alternative is to use one system as a stand-by for the other; but the complications and potential unreliability of change-over mechanisms (which are brought into use only in emergency) are better avoided altogether. Weighed against this must be the reduction to fifty per cent of the control-surface hinge moment if one side of an active system should fail.

Another consideration that figures in the design of a system is the question of mass-balancing the control surfaces; it would be possible to dispense with one jack and use a suitable anti-flutter damper if the surfaces were mass-balanced, but since in the case of a large aircraft the additional weight might be 700 or 800 lb, additional jacks and no balance are the obvious alternative. A further feature of the system shown is the pre-loaded spring box immediately upstream of each control servo valve; should a valve seizure occur, the linkage can be moved against the associated



Providing the pilot with feel proportional to equivalent air speed; as e.a.s. increases, the spring operating the force-controlled pressure regulating valve is compressed by the diaphragm, which reduces its effective area. This area reduction corresponds to the difference in the v and q stick-rate curves shown on the left; the latter characteristic can be obtained by replacing the spring with a rod.



The Hobson constant-speed alternator drive, developed in conjunction with Integral, the associate company. This drive forms the basis of the engine starting system shown below, right.

spring. This force would have to be held by the pilot while the seizure persisted.

With one addition, the complete circuit is now proof against any one major failure. If one valve seizes, the surface-section can be moved in one direction (by both jacks operating in unison) but not in the other (jacks in opposition) and the servo stiffness—with both valves open—is lost. This is easily remedied by inserting a non-return valve in the supply line and providing a by-pass orifice to act as a damper sufficient to suppress flutter; the surface-section can then trail to a position of zero hinge moment.

Feel simulation. It is now widely appreciated that artificial feel is required with powered flying-control systems, but it is interesting to relate that, although Hobson (from an English Electric suggestion) could provide some time ago any feel required, q-feel, corrected if necessary for Mach number effects to provide roughly constant stick force/g, has been almost universally adopted where springs would not serve. There is now, however, a resurgence of interest in special (i.e., unlike "natural" q-feel) systems, and a feel simulator is under development which provides an approximation to the "V" law—stick rate proportional to e.a.s. This is accomplished by a modification to the well-known hydraulic feel simulator and makes use of the fact that a diaphragm changes its area progressively with deflection. Apart from offering a choice of system, the component manufacturer has little say in the characteristics to be adopted, since this is a prime function of the control system of the aircraft. But where, for instance, it is suggested that the rudder control with advantage be made to increase foot load very rapidly with speed, a system might be developed which follows (as a basis) a V^2 law; and this is in fact being done by an inversion of the mechanical processes adopted to achieve a V law.

The q-feel simulator or its like provides an indication (in pitch) of the loads on the elevator and tailplane, but if the c.g. range is large, it provides no indication of the normal g built up or of the loads on the wings. On the other hand, a bobweight system provides a completely accurate indication of the normal g and the wing load, but does nothing to protect the tailplane during the period in which g is building up, and its inherent lagging qualities tend towards instability. Angular accelerometers can provide one solution; and another, proposed by Hobson, is to use a damper piston supplied with fluid at a pressure varying as q in conjunction with the bobweight. In this way, initially the stick force is affected both by the rate of application of surface angle and by the airspeed, while in the steady-state condition the stick force is entirely due to the bobweight.

Integrated starting systems. The advent of full A.C. electrical systems—a little slow to materialize on British aircraft, but an assured feature of new civil types—has resulted in a need for constant-speed drives to couple the engine and constant-frequency alternator. Several such drives (the Sundstrand/English Electric is typical) are already on the market, but a new design by Hobsons, in association with B.T-H., is so arranged that the alternator may be used as a motor for engine starting. At first sight the torque characteristics of an A.C. machine are unsatisfactory (see curves in col. 2 on the opposite page) in comparison with a D.C. starter or combined D.C. starter/generator, but advantage can be taken of the variable gear ratio of the constant-speed drive to run the alternator at its optimum conditions in the engine starting cycle, when it will function very efficiently. The starting time will, however, generally limit its use to bomber and transport aircraft, although the power curve during the starting cycle is completely flat and 45 h.p. should be available from an alternator of 40 kVA size.

The implications of A.C. starting in this manner are interesting. Self-contained starting of multi-engined aircraft could be achieved if one engine had a conventional starter, and the A.C. power it provided would be used to start the remaining engines. Similar systems have been suggested using both air-bleed and hydraulic power, but the A.C. system can be shown to have an overall weight advantage. There would be a small increase in weight of the alternator and drive combination.

Conventional engine starters would not, of course, be required other than for one engine. Alternatively, if an A.P.U. had been installed for other purposes, then an alternator on the A.P.U. would provide the electrical power for engine starting. As a further alternative, an electrical ground trolley might provide the power for normal starts, the self-contained starter being used only in emergency when no ground facilities are available.

The requirements for A.C. starting in this way are that the electrical machine is accelerated into, and run in synchronism with, the supply, and the engine is accelerated by changing the ratio in the constant-speed drive. It is obviously necessary that the constant-speed drive should have an overall gear ratio of infinity (the shaft connected to the engine being stationary, while the shaft connected to the electrical machine runs at any speed).

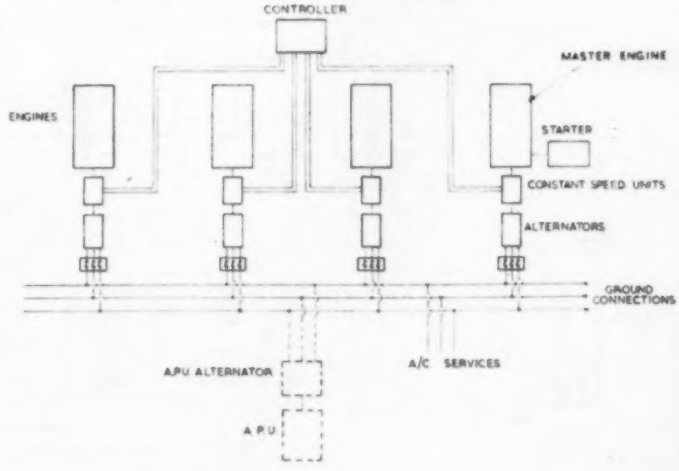
A typical starting sequence would be as follows: (1) Master engine running at ground idling r.p.m. and delivering A.C. power at the normal voltage and frequency to the aircraft electrical busbar; (2) starter motor (alternator) of the next engine to be started connected to line and accelerated to synchronous speed; (3) ratio control on the C.S.D. progressively altered to start engine—during this time the ratio is automatically governed by starter-motor current; (4) engine self-sustaining—control of the ratio transferred from starter motor current to alternator frequency; (5) repeat for remaining engines.

Another aspect of A.C. starting in this manner is that during the starting cycle it is essential that a mechanical reduction gear be interposed between the electrical machine and the engine, since although the C.S.D. could select a suitable torque multiplication ratio this would produce excessive internal hydraulic pressures. If an epicyclic reduction gear is arranged to include two free wheels, these can be used to ensure automatic selection of the correct ratio according to whether the engine or the electric motor is driving, and the reduction in torque transmitted by the hydraulics is accompanied by a proportionate reduction in fluid swept volume, size and weight. An accrued advantage of the interposed reduction-gear arrangement is that for a given size of unit the normal throughput of power is doubled and a C.S.D. nominally rated at 20 kVA can then transmit 40 kVA.

Before passing on to a consideration of further systems, it is worth commenting on the obviously undesirable differences in American and European practice on hydraulic fluids used in similar systems. Skydrol 500 has now been standardized in new American aircraft, but British designs continue to use mineral-based fluid to D.T.D. 585 specification. The main contention appears to be that Skydrol—which is water-based—is insufficiently non-inflammable to be considered a satisfactory substitute for the admittedly more inflammable D.T.D. 585; and, until the Ministry of Supply decree that a change should be made, no change is likely. Skydrol has a deleterious effect on some paints and needs special seals; but seals present no difficulties, and a wide range of sizes is already available. A possible disadvantage—although this does not apply to the same extent to civil aircraft—is that the maximum working temperature of Skydrol must be limited to 85 deg C.

Fuel systems. While this account has avoided any extensive review of Hobson's current activities, the progress of development has no clearly defined end or beginning and, in looking ahead at possible fuel-system developments, brief notice should be taken

Diagram of an engine starting system for a four-engined aircraft, operating through A.C. alternators and constant-speed drives. The auxiliary power unit or master-engine starter gives a self-contained system when external supplies are not available.



CONTROL SYSTEMS OUTLOOK . . .

of some of the systems in production and being developed today. The firm are, for instance, engaged in the manufacture of a self-contained reheat fuel system for an important modern engine. In this, they are leaning heavily on their experience in missile ramjet fuel-system design, because an afterburning engine displays at very high speeds the characteristics of quite an efficient ramjet. This system is for a fully controllable (as distinct from an on-off) reheat system and includes fuel metering, final nozzle control and the use of such features as a bleed-air turbo-pump or—for future more developed systems—a ram-air reheat pump.

In the production of systems for engines of such advanced design a stage is rapidly reached when present practice falls short of the system need. Hobsons, an old-established fuel-system firm (there was a Hobson carburettor on Alcock and Brown's Vimy) turned to hydraulics when the necessity arose. And in a similar way, the use of pneumatic (and in other applications, hot-gas) sensing units and servos is being explored as a logical answer to the demands of high temperature controls.

Typical in this respect is the control of fuel systems, variable-area jet-pipe nozzles, and so on. This may be achieved by sensing temperature but, even if electronic amplification of the signal is used, the response characteristics tend to be poor. If the turbine discharge temperature (in an engine with a variable-area nozzle), for example, is found by the probe to be too high, the reheat fuel supply will be adjusted and the temperature will be restored to a correct level. Before the temperature began its upward rise, however, a change must have occurred in the pressure ratio across the turbine, and if this can be sensed and used for fuel-system control, the system errors and lags will obviously be greatly reduced. Such a pressure-ratio control is manufactured in America by Solar Aircraft and is known as the Microjet. It is now possible to announce that negotiations for the licensed manufacture and development of Microjets by Hobson are in an advanced stage and should shortly be concluded. The advantages of the Microjet (its operating principles and applications were described in *Flight* for December 2, 1955) over other types of pressure-ratio control are that it consists essentially of a diaphragm-controlled contoured-needle valve, and the precision-construction of other units is absent.

With a control of this type, which measures pressure-ratio error regardless of the absolute pressure ratio, a wide field of opportunity is presented. An obvious application is the positioning of the shock-wave-controlling centre-body in a variable-geometry intake, since altitude correction is built-in. The pressure-ratio control could be used in conjunction with a hydraulic or pneumatic control and actuating jack, and in this part of the engine hydraulic-limiting temperatures will not be reached quite so quickly. Pressure-ratio parameters can also be used for engine acceleration fuel-metering and the consequent reduction of compressor surge effects.

Lay criticism that aircraft fuel systems are over-complicated is, on examination, well founded. But the need to present clean fuel, free from water that may cause sensitive controls to ice up, and fed from tanks in the correct proportions, requires a relatively large number of components in any one system. Here is an obvious path for development, and Hobsons foresee (as the result of design investigation) new and radically simpler systems for civil aircraft. The basis for any such arrangement is to design-in an appreciable dirt-swallowing capacity and so eliminate the need for filters, filter heaters and so on. Continuing this trend, it becomes logical to dispense with piston-pumps, pintle nozzles and sliding valves and use centrifugal pumps, large orifice spill-flow distributors, small pressure-drops across metering needles, and throttles with large clearances that cannot be jammed by particles of dirt or ice.

Much can also be done with flow proportioners. One idea is to use a proportioner unit with paddle-type rotary dividing members with large clearances and virtually no pressure drop. An air motor (driven by compressor bleed) is used to drive the paddles at a speed which is a function of the flow required, and the system is thus insensitive to changes in specific gravity. A parallel development line is to use the Integral-manufactured Faure-Herman flowmeter system in the development of an electrical fuel-flow proportioner which would sense flow-rate, pass the information to a computor, and so regulate the flow. Nearly all the moving parts would consequently be remote from the fuel; this approaches the ideal of submerging only a fuel-rate sensing element and a throttle to regulate the flow of fuel direct to the burners. The electronic controlling element, divorced from the fuel lines entirely, could also be coupled to an air data computer to form the basis of an electronically controlled fuel system. This system would provide really accurate control of the fuel flow by any number of parameters, and such bogies as seized pistons and jammed valves would be eliminated.

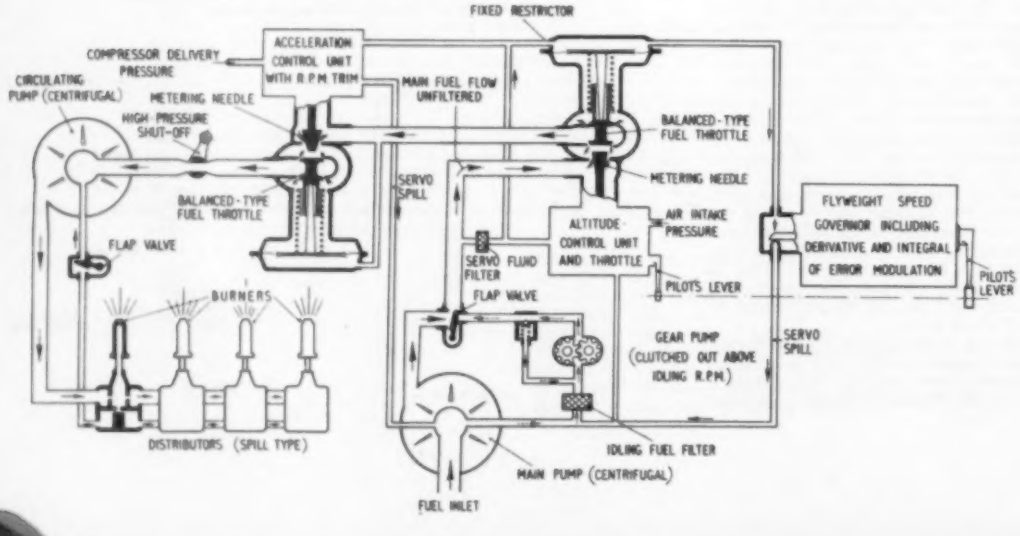
The basic simplicity of this attractive "next step" could also be usefully employed in a multi-engined system, such as those used in vertical take-off aircraft. Hobsons already have practical experience in this field.

One of the problems soon to be faced is that extensive use is to be made of the thermal lag of the fuel in the tanks as a coolant, which will pass into the engine at 300 deg C. The effect of this added heat in the powerplant is, of course, advantageous, but future seals, contents gauges and other fuel-systems components will have to work at much higher temperatures than hitherto. A fuel system with only a flow sensing element and throttle in the fuel line, both relatively easy to develop for these temperatures, will thus show to considerable advantage.

Other developments. *Flight's* post-Farnborough comment that an opportunity appeared to exist for the manufacture of a taxying unit for jet aircraft was answered some weeks later by an announcement from the Consolidated Diesel Electric Company of Canada, who have developed a prototype unit for the Boeing 707 and DC-8. This firm are also concerned with arrangements for manufacturing their product over here. But it would be wrong to assume that British manufacturers are neglecting this development or even regarding "wheel-movers" as a piece of ground equipment, since the sophisticat.d solution is a self-contained unit; probably with power generated by an A.P.U. and supplied hydraulically to the wheels. This type of equipment is attracting the interest of Hobsons' associate company, Integral Ltd., who are also marketing a substantial range of hydraulic pumps and motors developed at their own works on the other side of Wolverhampton. Apart from this distinction, the shops of both manufacturers are broadly similar in appearance—fine engineering allows little laxity in the discipline of workshop organization. An independent line pursued by Integral is the production, marketing and development of the Faure-Herman flowmeter, a future adaptation of which has already been discussed. This firm is perhaps best known for its hydraulic pumps (many examples of which are in service on numerous aircraft) and developments in this line include small, very high speed units, particularly suitable for missile use.

Competition within the equipment market is likely to continue to be based on technical merit and established reputation, but the capacity—towards which these two firms are working—to offer simple, long-life equipment in anticipation of the operators' need, is likely to be a vital third factor that no one in the component industry can afford to ignore.

A.T.P.



The logical next step in fuel-system development. This arrangement has been designed to have a substantial dirt-swallowing capacity; special features include large-orifice spill-flow distributors, metering needles and throttles with large clearances and small pressure drops, centrifugal rather than piston pumps, and filters for the servo system fluid only.

Boeing B-52

THE STRATEGIC STRATOFORTRESS

BY THE TECHNICAL EDITOR

A PHILOSOPHER would no doubt condemn the human race for the fact that the world's largest aircraft-building programme (measured in cost, man-hours and airframe weight) should concern a machine designed specifically for causing fearful destruction. From the purely academic viewpoint, however, the Boeing B-52 is an outstanding technical exercise. Surrounded as we are with global ballistic missiles, moon rockets and satellites, it is appropriate at this time to sit back and evaluate the world's mightiest bomber, the like of which we shall not see again.

Ten years have passed since the U.S.A.F. Strategic Air Command came into being. As the American instrument of "massive retaliation" it is equipped with some of the largest aeroplanes in the world. Notwithstanding S.A.C.'s global network of bases and huge establishment of tanker aircraft for in-flight refuelling purposes, none of its equipment has a gross weight of less than 200,000 lb. The fact remains that, in the present state of the art, the longer the range of an aeroplane, the bigger that aircraft must be; and in the B-52 the U.S.A.F. asked for longer range than had ever previously been attempted in a jet aircraft. An outline of how the B-52 came to be designed was given in our issue of December 5, 1952, when the prototypes were in the early stages of their flight trials. Now the B-52 is in large-scale service with S.A.C., and it is possible to learn much from its performance and its problems.

It is hardly necessary to say that the B-52 was designed by the Boeing Airplane Company, of Seattle, Washington. Its basic configuration may at first appear unconventional, but familiarity with it reveals an imaginative simplicity whereby, within the vast framework of the airframe, self-contained packages serve the functions of propulsion, crew accommodation, undercarriage, armament systems, accessory power and so forth, all portions being completely accessible and capable of ready assimilation by the thousands of maintenance engineers in S.A.C. Even the enormous airframe itself is an assemblage of sections built by firms spread throughout the U.S.A. and shipped to Boeing, where they are assembled with complete interchangeability.

It is not proposed to describe the structure in detail, since a general indication can be gleaned from our cut-away drawing overleaf. It is, however, worth commenting on the extraordinary flexibility of the airframe. During static testing the wing tips were moved vertically through 32ft; and, even at rest, the fuselage sags nearly an inch at each end, as the skin-wrinkles testify.

Eight thousand hours of tunnel testing preceded the final choice of wing design, which provides a very high lift/drag ratio for long-range cruising and offers an internal volume so great that only part of it is required to accommodate fuel cells. Most of the wing is a giant box formed by two principal spars, joined by ribs on which are mounted machined spanwise stringers carrying what are probably the largest pieces of skin used in any aircraft. The latter are continuous from the root to the break-joint 84ft away, and they are machined and tapered over their entire area, reaching a maximum thickness of 0.4in at their inner ends. The secondary structure in the rear part of the wing is stabilized by metal honeycomb by such suppliers as Hexcel, Narmco and Kawneer.*

Port and starboard wings are attached at their roots to a stub-structure forming a bridge piece of the same width as the fuselage. Major loads are transmitted from the heavy wing-skins through spanwise bolts arranged around the periphery of each wing root, while the front and rear spars are located by large bolts at the mid-depth position. On the front spar these bolts also transmit the weight of the wing and powerplants to the strong frame carrying the front trucks of the landing gear.

To a large extent the fuselage is a series of cantilevered sections hung from the wing stub-structure, which is attached to the front centre fuselage portion. Heavy frames carry the fore and aft landing-gear units and a horizontal floor-web separates the bomb bay from the fuselage fuel cells. The lower edge of the side panels terminates at a strong keel member of triangular section which takes fuselage loads past the cut-outs provided for the undercarriage and bomb bay. The long, tapering rear-fuselage sections carry the tail and pressurized gunner's compartment, and the latter is joined by an unpressurized catwalk along the starboard side of the aircraft to a door in the rear pressure bulkhead of the crew compartment in the front fuselage.

The towering vertical tail can be folded to starboard to allow the B-52 to enter hangars of normal height. The horizontal tail, which has a root chord not much less than that of the wing, is pivoted aft of mid-chord and is hydraulically moved for trimming purposes. At the front of the central bridge structure of the tailplane are two ball-bearing nuts running in a vertical screw (by Foote Brothers) provided with two threads in opposition. Both the jack-screw and the nuts are driven by hydraulic motors in separate circuits, so that failure of either circuit merely halves the drive speed. Maximum jack-screw travel is 43in/min under a 56,000 lb load, and the static limit is 158,000 lb. Complete hydraulic failure still leaves the aircraft trimmable, since the gunner can operate the elevator manually *via* a 200:1 gearbox.

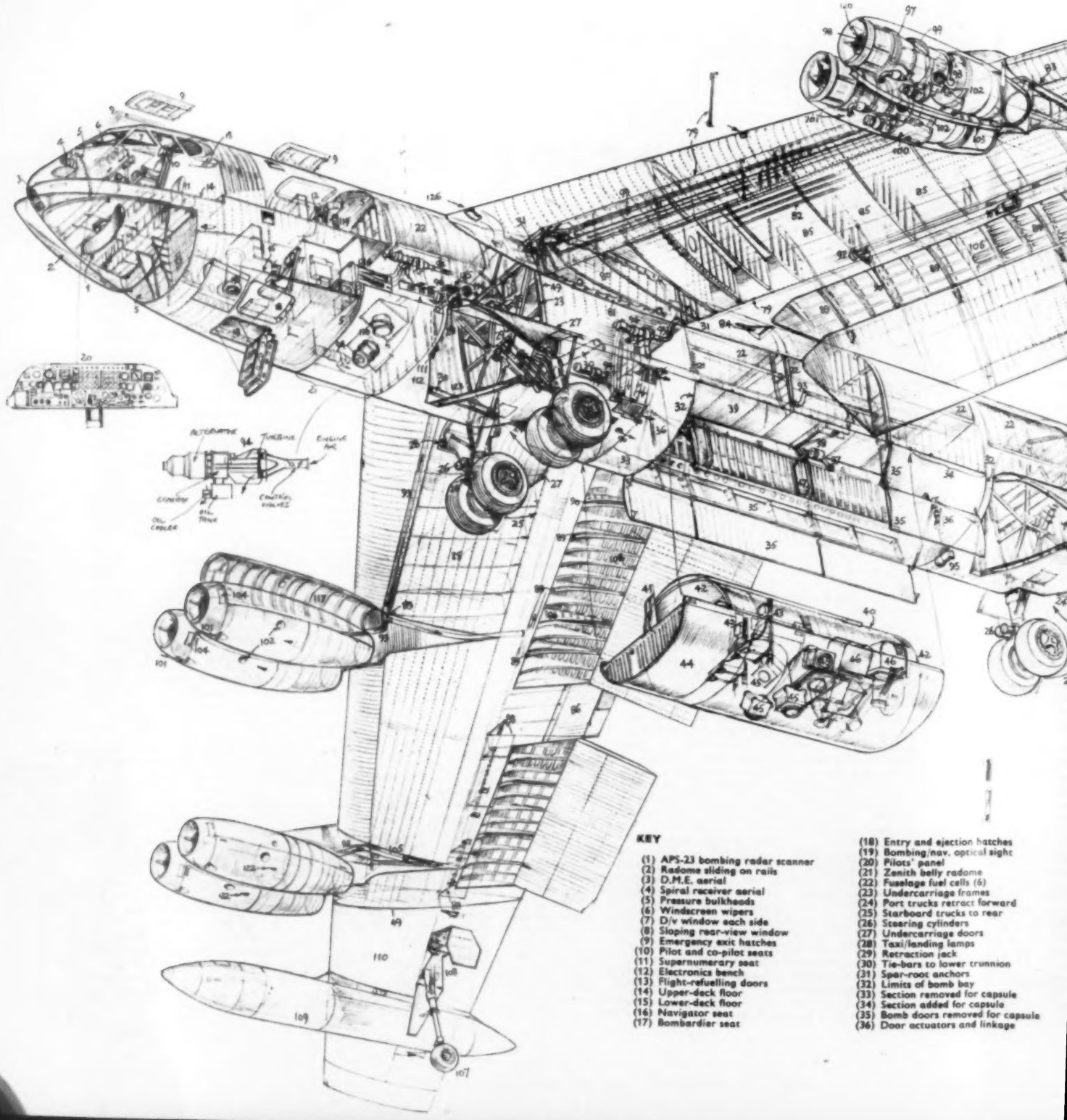
Several features of the flying-control system are unusual. The surfaces themselves are of exceedingly narrow chord and, except for the spoilers, are operated entirely manually by aerodynamic tabs. The elevators and rudder require little comment except to note that the leading edge of the latter surface is of reinforced plastic by Zenith. Lateral control is provided by small flipper-type ailerons, mounted well inboard and effective only at high indicated airspeed, together with extremely powerful spoilers arranged in seven sections above the wings (the three-view drawing on page 774 shows their position and also indicates the "turbulators" ahead of the flipper ailerons). For maximum rate of roll all spoiler sections can be opened on one wing only; No. 2 spoiler position can trim out asymmetric loads resulting from engine failure, and opening of all spoiler sections combines very great braking effect with destruction of an appreciable proportion of the lift of the wing, which is most valuable for rapid let-downs and during the landing run. Spoiler operation is hydraulic. The enormous flaps

(Continued on p. 774, after double-page drawing of B-52.)

**Naming of a sub-contractor or supplier does not imply that that company is the sole producer of the part concerned.*

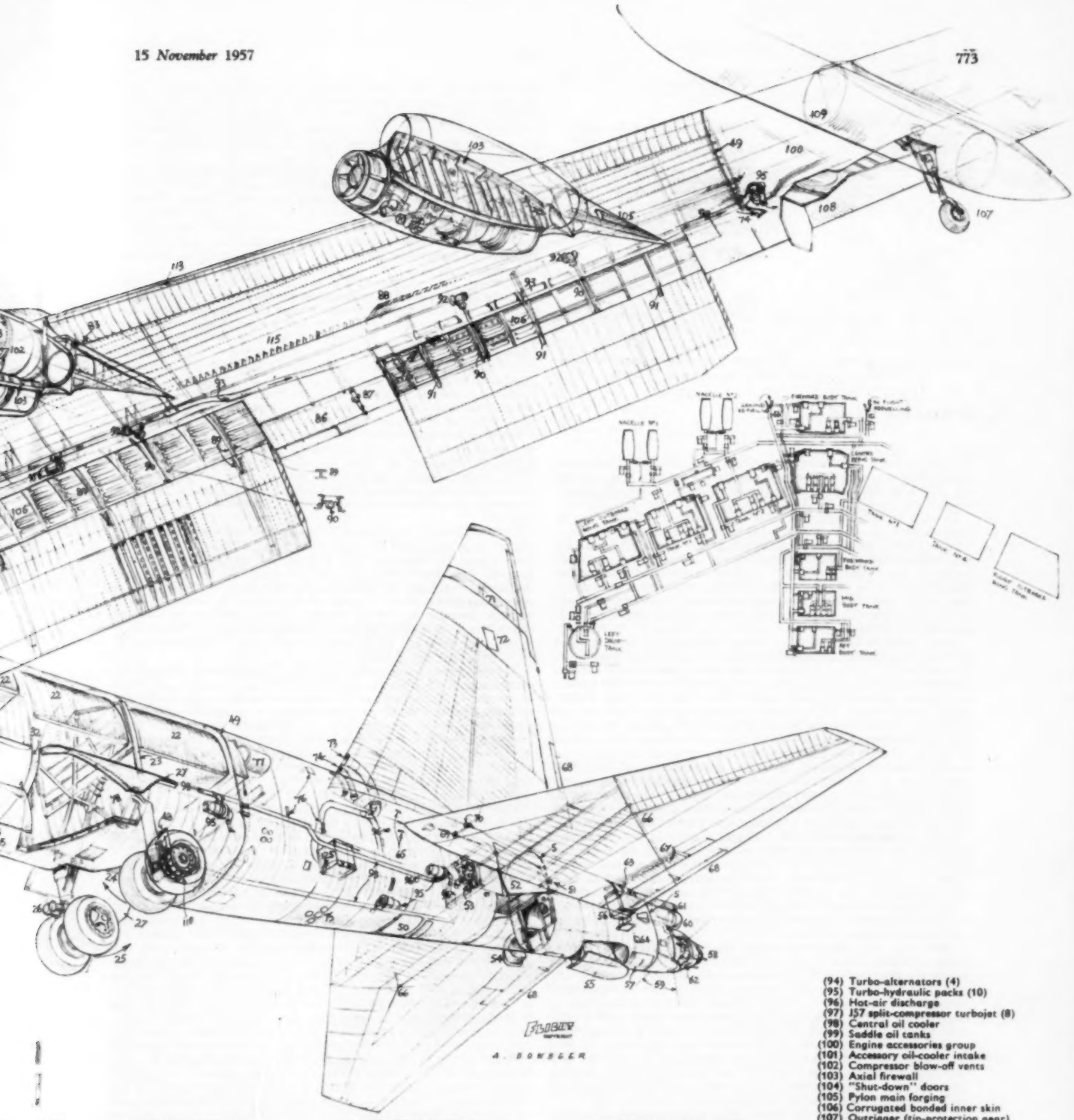
BOEING B-52 . . .

This drawing depicts the essential features of the Boeing B-52C, one of the most important versions currently in production. It is a multi-purpose aircraft, equipped to carry the reconnaissance capsule shown beneath the bomb bay. Basic data are given on p. 774. American terminology has been retained in the schematic fuel-system diagram opposite.



KEY

(1) APS-23 bombing radar scanner
(2) Radome sliding on rails
(3) D.M.E. aerial
(4) Spiral receiver aerial
(5) Pressure bulkheads
(6) Windscreen wipers
(7) D/v window each side
(8) Sloping rear-view window
(9) Emergency exit hatches
(10) Pilot and co-pilot seats
(11) Supernumerary seat
(12) Electronics bench
(13) Flight-refuelling doors
(14) Upper-deck floor
(15) Lower-deck floor
(16) Navigator seat
(17) Bombardier seat
(18) Entry and ejection hatches
(19) Bombing/nav. optical sight
(20) Pilots' panel
(21) Zenith belly radome
(22) Fuselage fuel cells (6)
(23) Undercarriage frames
(24) Port trucks retract forward
(25) Starboard trucks to rear
(26) Steering cylinders
(27) Undercarriage doors
(28) Taxi/landing lamps
(29) Retraction jack
(30) Tie-bars to lower trunnion
(31) Spar-root anchors
(32) Limits of bomb bay
(33) Section removed for capsule
(34) Section added for capsule
(35) Bomb doors removed for capsule
(36) Door actuators and linkage



A. BOWBELLER

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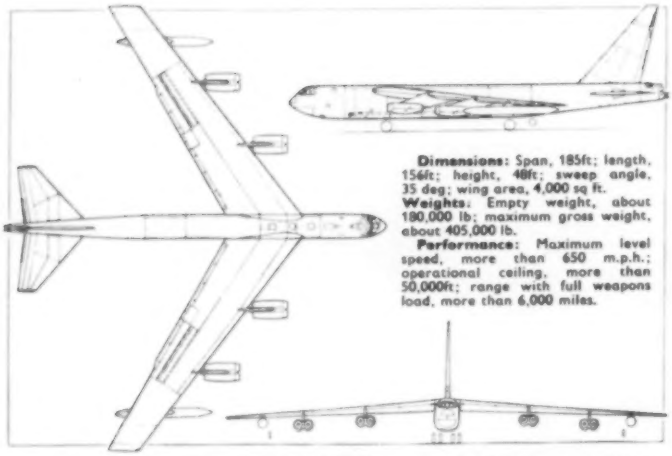
(37) Weapon crutches
(38) Powered stores-winch
(39) Weapons-bay roof
(40) Pressurized capsule
(41) Mounting brackets
(42) Domed bulkheads
(43) Downward-ejection seats
(44) Electronics area
(45) Four cameras
(46) Cameras or countermeasures
(47) Communicating walkway
(48) Door to rear fuselage
(49) Airframe break-joints
(50) Access hatch
(51) Tailplane fulcrum
(52) Gap shroud
(53) Tailplane jack-screw
(54) Gunner's entrance
(55) Box for 48ft ribbon canopy

(56) Rear-facing gunner seat
(57) Access door
(58) Four 0.5in guns
(59) Turret gimbal axes
(60) Monopulse radar scanner
(61) Optical hemisphere sight
(62) Case/link chutes
(63) Heated windows
(64) Emergency turret-jettison
(65) Tailplane limits +7, −6 deg
(66) Cranked main spar
(67) Elevator balance panels
(68) Control servo tabs
(69) Fin-fold hinge axis
(70) Fin locking pins
(71) Structural dielectric isolator
(72) V.O.R. aerial window
(73) Intake to gunner's air system
(74) Air to hydraulic-pack oil cooler

(75) Identification light group
(76) Slinging points
(77) Water or hydraulic tank
(78) Rear gear is facsimile of front
(79) Wing-box front and rear webs
(80) Ribs fan out until normal to spar
(81) Tie-bolts, 13 top, 11 bottom
(82) Stringers riveted to machined skin
(83) Kink in front spar
(84) N.A.C.A. fuel-vent intake
(85) Bag tanks between ribs
(86) Flipper aileron
(87) Tab actuator
(88) Spoilers on upper surface
(89) Inner flap rails and cam-followers
(90) Flap ball-bearing jack-screws
(91) Outer flap rails
(92) Hydraulic motors
(93) Compressor bleed tapping

(94) Turbo-alternators (4)
(95) Turbo-hydraulic packs (10)
(96) Hot-air discharge
(97) J57 split-compressor turbojet (8)
(98) Central oil cooler
(99) Saddle oil tanks
(100) Engine accessories group
(101) Accessory oil-cooler intake
(102) Compressor blow-off vents
(103) Axial firewall
(104) "Shut-down" doors
(105) Pylon main forging
(106) Corrugated bonded inner skin
(107) Outrigger (tip-protection gear)
(108) Outrigger well and door
(109) Jettisonable tanks, 2,498 Imp. gal
(110) Integral tank in late models
(111) Air connection for engine-starting
(112) Pressure-fuelling socket inside
(113) Leading-edge de-icing air
(114) Exhaust from air-conditioning
(115) Turbulators on upper surface
(116) Aerials, probably e.c.m. reception
(117) Detachable, hinged cowlings
(118) Goodrich tyres, wheels, brakes
(119) Static apertures
(120) Pressure sensing probe
(121) Main jacking points
(122) Jet-pipe cooling air
(123) Batteries in forward truck bay
(124) Cooling air to alternator packs
(125) Cabin air-conditioning packs
(126) Ram-air intake to 125


Dimensions: Span, 185ft; length, 156ft; height, 48ft; sweep angle, 35 deg; wing area, 4,000 sq ft.
Weights: Empty weight, about 180,000 lb; maximum gross weight, about 405,000 lb.
Performance: Maximum level speed, more than 650 m.p.h.; operational ceiling, more than 50,000ft; range with full weapons load, more than 6,000 miles.

General arrangement of the B-52C, powered by eight Pratt and Whitney J57-P-29W engines each with a wet rating of 12,800 lb.

Boeing B-52 . . .

are carried on cam followers, provided with integral Torrington needle bearings, which move out along steel tracks. The surfaces are driven by Saginaw ball-bearing jack-screws and Foote angle-boxes from spanwise torque tubes coupled to hydraulic motors.

In view of the dispersed nature of the aircraft, Boeing had to adopt a landing gear configuration even more unusual than the bicycle gear of the B-47. The weight of the aircraft is borne by four twin-wheel trucks mounted at the corners of the centre fuselage. The latter structure is stressed to permit the aircraft to alight at maximum landing weight on either front truck plus either rear truck, and this extreme case is naturally continued down through the gear itself as regards stressing, foot-print pressure and braking ability.

Each truck is attached to a strong bulkhead along a pair of inclined hinges which accept the forked tops of the truck legs. The inclination of the hinges pulls each truck inwards as it retracts (the port trucks go forward and the starboard go aft). Each main leg carries paired hydraulic jacks which can steer the wheels through ±20 deg. For ground manœuvring, the fore and aft trucks can be steered independently and in opposite directions, but synchronized inclination of all four trucks permits the aircraft to move crabwise and confers singular benefits during cross-wind landings. After obtaining the wind from the tower, the pilot merely has to read off the vector component according to his landing weight and turn all four trucks through the correct drift angle before starting his final approach. The cross-wind gear was first tested on a B-47 in 1952 and has proved a great success.

Each mainwheel carries a 56 × 16 tyre and has multi-disc brakes with Hytrol control (their effect is supplemented by a braking parachute in a box under the rear fuselage). To increase lateral stability on the ground the B-52 also carries outrigger wheels, officially termed "tip-protection gear," with a track of no less than 148ft. When the aircraft is parked the outriggers may be suspended in the air or pressed against the ground, depending on whether or not the wing tanks are filled.

All B-52s are powered by eight Pratt and Whitney J57 two-spool turbojets, which in the early days of the project were as new as the aircraft itself. The engines are hung in pairs on either side of a vertical firewall carried on long titanium and stainless-steel pylons which position the engines well forward of the leading edge of the wing. Each complete powerplant-group and nacelle weighs more than 11,000 lb, and is hung on four precision bolts passed through trunnions on the main wing box. Rohr supply complete pods and the cowlings are also manufactured by Bell Aircraft in Buffalo. The whole of the underside of the cowling hinges open, revealing the powerplants at a suitable working height for a man standing on the ground.

Each engine carries a saddle oil tank with a capacity of no less than 13½ Imp. gal (indicative of the endurance of typical missions), the oil cooler being mounted centrally in the engine intake. Injection water is carried in Goodyear cells above the pylon struts, from whence it is fed by air-turbo pumps during maximum-weight take-offs (each of which can consume 250 Imp. gal of water). The engine fuel pumps, by Chandler-Evans, are of the two-stage gear type, the stages being paralleled during starting and then placed in series. G.L.A. high-energy ignition boxes are used and Fenwal fire and overheat detectors are arranged along the nacelles, with settings at 450, 675 and 750 deg F.

In its accessory systems the B-52 breaks completely new ground. Except in the most recent versions of the aircraft, virtually all accessory power is obtained pneumatically, a "bloodstream" of air at 750 deg F and 205 lb/sq in gauge being bled from the second spool of each J57. It was the weight factor which finally caused Boeing to adopt such a system, and it is used to energize the hydraulics, electrics, air-conditioning, water injection and de-icing.

Bleed-air from each engine is extracted by a manifold which joins the supply from the adjacent engine and takes the combined flow up the pylon strut into the wing. The four inner engines feed inboard along the leading edge and the outboard powerplants pump air to the back of the wing-box and back along the trailing edge (both ducts are joined by chordwise pipes with shut-off valves which can be opened in the case of partial system failure). The ducting, by Solar Aircraft, is made of annealed or work-hardened stainless-steel from 0.016 to 0.078in thickness with an outside diameter of 2½ to 5in. Most runs are overlaid with a 0.5in layer of glass-fibre and neoprene-impregnated glasscloth. Numerous failures resulted from the high-velocity flow of hot air, which caused disastrous resonance at duct irregularities. The supporting brackets are now not allowed to deflect more than 0.06in under a transverse load of 1,000 lb. Duct joints are made with V-band seals provided with Goetze (Johns-Manville) gaskets consisting of an aluminium sheath over a core of fine steel-ribbon mesh.

Hydraulic power is provided by ten General Electric turbo-pumps each delivering 6.7 Imp. gal/min at 2,650 lb/sq in. Four pumps feed the undercarriage, brakes, steering and bomb doors; four more packages drive the spoilers, flaps and outriggers, and the final pair actuate the tailplane. Further notes on the hydraulic system are given later. Typical of the system is the centralized package supplied by Parker Aircraft which combines a mass of check valves, by-passes, filters, restrictors and similar devices in a single unit; there are ten on each aircraft with a weight-saving of 50 lb over distributed units.

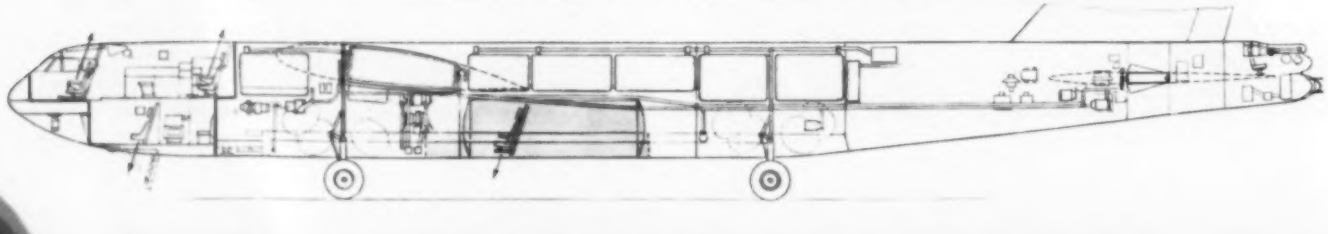
Electric power is generated by four Westinghouse alternators, each rated at 60 kVA and delivering 400 c/s current. All four units are mounted in the fuselage in current aircraft (future machines have a different arrangement, as presently described) where they are driven by G.E. or Thompson air-turbines controlled by Sanders boot-strap valves operating on the two-stage internal force feedback principle. Most of the electrical loads are absorbed by the extensive radar and electronic parts of the B-52 weapons system, and there are over 57 miles of wiring in the 18,000 separate circuits involved.

Fuel is contained in flexible cells, reminiscent of an airship's gas bags, requiring 1,550 sq yd of nylon fabric and 3,000ft of nylon lacing. These are distributed throughout the upper part of the fuselage and along the wing box to the junction with the outer panel, the total capacity being 29,143 Imp. gal. Current B-52s also have large underwing tanks, as described later. The fuselage cells are larger than those fitted to any other aircraft, and they are fabricated by Goodyear to fit exacting cut-out and sump areas. To protect the bags against damage they are supported by smooth Swedlow resin-reinforced nylon cloth. Hydro-Aire pumps are employed and Norden-Ketay supply flowmeters which sense the flow by the deflection of a sprung vane. Movement of the latter actuates magnets which are geared to a synchro which feeds a panel indicator. Linear synchros in the feed to each engine are connected in series to an amplifier, which rotates a gear-train driving a totalizer indicating an aggregate flow of up to 100,000 lb/hr. The ground-fuelling connection is in the front landing-gear bay, and the air-refuelling socket in the top of the forward fuselage.

Most of the cabin-conditioning units are mounted in the rear lower part of the forward fuselage, to which bleed-air is piped to provide pressurization power and a source of shaft power for the air-cycle units. The refrigerating system is by the Stratos Division of Fairchild and it includes large Stewart Warner ram and blower heat exchangers.

De-icing is effected largely by hot air beneath the skin, and over 2.8 m B.Th.U./hr is required for the wing and empennage alone. The sealant used in the de-icing ducts has to withstand a

Complementary to the main drawing on the previous pages this sectional view clarifies the disposition of the fuselage tanks and the capsule (shown shaded). Pressure bulkheads are drawn in heavy lines; arrows show seat-ejection direction. Wing incidence is noteworthy.



temperature range from −65 to 500 deg F. Hot air is also piped around the intakes of the engines and oil coolers. Almost all the 24 windows over the crew spaces are electrically heated, the outer panels being Nesa glass.

Such were the features of the first two prototype aircraft, the XB-52 (49-230) and the YB-52 (49-231). The former was "rolled-out" from the Boeing plant in Seattle on the rainy night of November 29, 1951, its details obscured by an enveloping sheet. It did not fly until eleven months later, having been "cannibalized" to speed the completion of the more advanced YB-52, which was rolled-out in March and flew on April 15, 1952. "Tex" Johnston, B-52 project pilot (now Boeing chief of flight test), and Col. Townsend, of the Air Research and Development Command, were at the controls of the tandem-seat YB-52, and the former has written of it:—

"We were perched at the north end of Boeing Field's 10,000ft runway, Lt-Col. Guy M. Townsend and I, making our final check of the Boeing YB-52 Stratofortress while its eight jets squealed their impatience to get into the air for the first time. We completed the check and I took a deep breath as I reached for the throttles.

"We started to roll. Guy said, 'All engines on full power,' and as we gained flying speed I cut loose with a sudden exuberant yell. This is the point at which a test pilot gets his big thrill. It's the payoff for all the work that you've expended in preparation for this moment. You're in command of a huge, highly complicated piece of flying equipment into which millions of hours of work have gone, but until now has been merely a static monster. Now it comes to life, and you can feel it.

"We still had more than half of the runway in front of us when I lifted the big plane into the air. We took off easily and cleanly and headed south at a low angle of climb. A few miles to the south of Boeing Field the Seattle-Tacoma International Airport at Bow Lake had been closed to all other aircraft just in case something went wrong and we had to set the ship down. Further to the south, McChord Air Force Base, near Tacoma, had its runways cleared for emergency use, while Paine Field, some 25 miles north of Seattle, also was standing by. We kept the landing gear down as we made a wide sweep of the Puget Sound area, slowly gaining altitude. The airplane handled nicely—almost like a fighter despite its tremendous size—and after sticking relatively close to our three emergency fields for about 40 minutes we pulled the gear up and headed for Larson Air Force Base at Moses Lake in central Washington.

"First flights of experimental airplanes generally are brief, but this airplane was handling perfectly and behaving like an angel, so we decided to depart from the usual and expected. We started our flight testing right then and there, going through one phase after another. We had been in the air for almost three hours before we decided to call it a day, and when I eased the airplane on to the Moses Lake runway our paper work contained remarkably few 'squawks' despite a generous run of tests. I was already convinced that this new Boeing bomber was not only a good airplane, it was a hell of a good airplane."

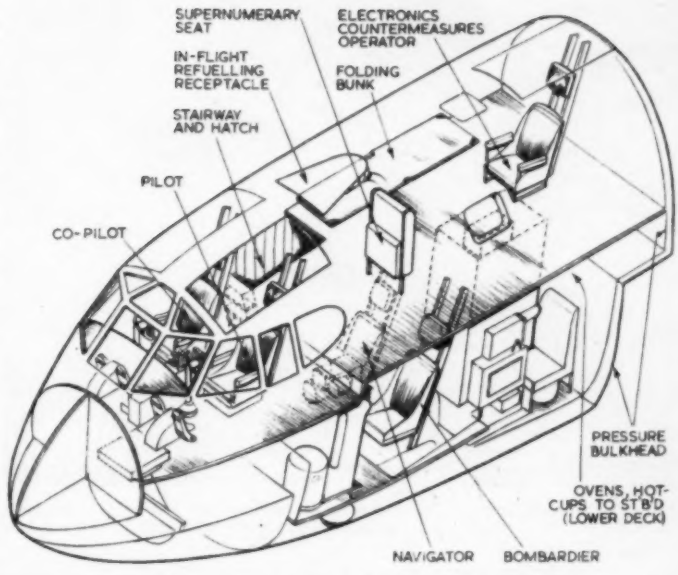
So great was the task of evaluating the B-52 in the air that Boeing's flight-test organization rapidly swelled to over 600. More than 85 per cent of all B-52 flight time produced actual test results, and the routine airborne equipment included 23 miles of tube and wire, up to eight 43-channel recorders (reading perhaps 432 temperatures simultaneously) and time-multiplexers capable of sampling each of 420 channels 2½ times per second and thus putting eight million readings on 10½in of magnetic tape during two hours of flying.

Boeing opened an impressive $5m flight-test centre at Seattle in June 1954 and capped this with a $10m establishment at Moses Lake (Larson A.F.B.) where all production testing and calibration has since been based. No B-52 was lost during development flying, but there were many unforseen occurrences. At least one landing was made with one truck retracted; and on another occasion one of the trucks jammed at the full 20-deg inclination, with the result that several dozen man-hours were expended in scraping rubber off the fuselage. As late as 1955, during Phase VI testing at Edwards A.F.B., it was found that the flaps were cracking under the ultrasonic noise intensity of water-injection take-offs.

An accompanying drawing outlines the arrangement of the flight deck. Originally the U.S.A.F. requested that the two pilots be seated in tandem, but experience with the B-47 indicated that this arrangement was wasteful of space and had several other drawbacks. Tandem seating was, however, incorporated in the two prototypes. In the B-52A, the first production version, the final configuration was reached. Fully pressurized to equivalent levels of between 7,000 and 10,000ft at operating altitudes of up to 50,000ft (design dP is 8.77), the flight deck has operating stations for a flight crew of five (excluding the tail gunner), and rest or supervisory areas for as many more.

All crew on duty sit in ejection seats, by Weber or Rheem, those on the lower deck being arranged to fire downwards. The navigator's seat slides forwards when all the crew are aboard, and ejects through the main entrance doorway. The forward-facing windows have Marquette wipers and are glazed with ¼in full-tempered glass, 0.34 vinyl and ⅜in semi-tempered glass with a Nesa conducting layer. Crew oxygen is supplied from Aro 8-litre converters. Conventional flying clothing is normally worn, although for extreme-altitude missions the somewhat uncomfortable MC-1 partial-pressure suit is mandatory.

So far the B-52 has been considered only as an aeroplane, but it is designed as a weapon system. Heart of the system is the complex bombing/navigation equipment, designated AN/ASB-4, MA-2 or MA-6A. This is largely responsible for the fact that the B-52 electronics weigh 6,000 lb.



Five of the operating crew occupy the two-deck nose of the B-52, the sixth man being the tail gunner 150ft away. Up to six additional men, such as specialist ground-crew, can be carried on board.

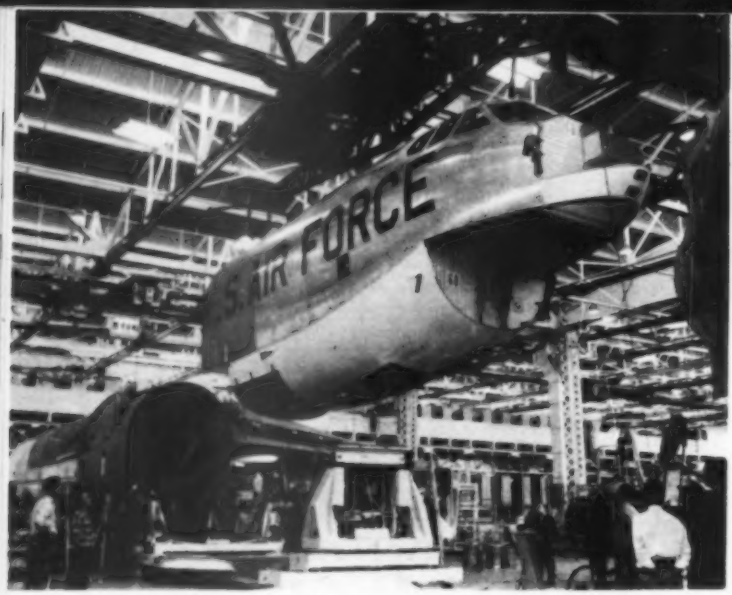
Development of the original Sperry-Rand K-system began during World War 2 and this equipment is standard on B-36s and B-47s. The final form is the K-3A (U.S.A.F. designation MA-6A) which is in production for about half the B-52s, in association with the A-14 flight-control system. The latter incorporates "parameter control" claimed to apply to each control surface "the exact force to execute any manœuvre required."

The remainder of the B-52s, and possibly all the advanced versions, carry the MA-2 BRANE system, by International Business Machines. This began as a study by the Perkin-Elmer Corp. in 1951, when the K-system was insufficiently reliable. BRANE weighs 1,457 lb, has over 300 thermionic valves and costs more than $300,000. It involves a large bombing radar (SN-47/APS-23) by Raytheon, operating on both pulse and C.W. techniques and housed under the pilots' floor, where it is pressurized by a Lear-Romec unit (delivering at sea-level and at a greater pressure) and faired by a large Zenith radome. Basically the MA-2 system units are tied by a computer, of analogue type but also required to count pulses. An optical sight is provided for the bombardier for checking purposes, and the whole system is very painstakingly engineered to ensure reliability.

The earliest B-52s were specifically equipped for either bombing or photo-reconnaissance, but Boeing have developed an ingenious "capsule," looking like a large cylindrical boiler, accommodated within the weapons bay with which a bomber B-52 can be converted to serve other functions. The capsule is fully pressurized and air-conditioned and is provided with downward-ejecting seats for two crew-members, together with four or more cameras, countermeasures and other electronics systems, a large radar scanner and other aerials and certain other devices. The capsule is carried by B-52Bs and B-52Cs and equips these bomber aircraft for photographic or countermeasures missions.

Defensive armament, eschewed by British bombers, takes the form of a manned gun turret at the tail. Early B-52As had a G.E. turret with two 20mm guns, but the standard pattern now is the MD-9 system controlling four 0.50in guns. Prime contractor for the MD-9 is Bosch Arma, with a unique monopulse radar by G.E.'s light military electronic equipment division; second-source production is by Avco (Crosley division) with radar by Ramo-Wooldridge. In addition, Admiral supply fire-control radar and there is a final optical sight by General Mills or Eastman Kodak. Ammunition is fed from under the tailplane by Arma feed-boosters, operating on 400 c/s current, which counteract the 50-lb belt pull at 1,400 rounds/min and pass 84,000 rounds without servicing.

Other weapon system components include the countermeasures, of supreme importance to such an aircraft. Sperry are producing e.c.m. packages against a $50m to $80m contract, and certain parts of the e.c.m. are carried in the reconnaissance capsule. Camera systems, also carried partly within the capsule, operate on visual light and infra-red. Communications radio includes the ARC-21, by R.C.A., capable of operating on any 20 of 44,000 frequencies; ARC-21 is housed in a pressurized box under remote pilot control, and it can maintain global voice-contact with S.A.C. headquarters at Offutt A.F.B., the aircraft's home base, or tanker aircraft.



Although the various parts of the airframe are built in different parts of the U.S.A., no section has yet failed to fit its neighbour.

Boeing B-52 . . .

A production order for 500 B-52s was placed before the first aircraft flew. While Seattle tooled up for the B-52A and B-52B, the Boeing plant at Wichita was established as a second source. Rapidly the B-52 programme built up into the largest aircraft-manufacturing task in the world; more than 5,000 firms are directly involved, and 65c out of every B-52 dollar goes to subcontractors.

Parts for the B-52 come from far afield, as a structural breakdown below indicates. Some 41 per cent of the airframe is sub-contracted, and in spite of their immense size all portions are built to a maximum tolerance on mating surfaces of 0.02in. Wing jigs weigh over 1,000 tons; precision-forming of wing chordal webs 14ft long and 1¼in thick requires a 360,000-lb Sheridan stretch-press, and half the manufacturing time is spent in fitting well over half a million rivets—costing from 14c to $1 75 each—into every aircraft. Even the thickness of paint is measured, and in some cases coatings are held to 0.00004in. The need for such precision is brought home when it is pointed out that an extra 0.005in. on one of the giant wing skins would add 275 lb to its weight.

First aircraft to come off the Seattle line was 52-8710, the first B-52A. This mark has J57-P-9 engines and 833-gal underwing tanks. It was soon followed by the B-52B and RB-52B, the latest versions of which have provision for the reconnaissance capsule. Operationally equipped aircraft of these marks began to reach the U.S.A.F. in June 1955.

Introduction of the aircraft to the U.S.A.F. was assigned to Castle A.F.B., where were established the 93rd Bomb Wing, as an operational unit, and the 4017th Combat Crew Training Sqn. to handle all B-52 crew-training for S.A.C. units. Conversion of each crew takes ten weeks, although it is estimated that five months usually elapses between operations on B-36s and operations on B-52s. Flight crews spend one day planning a mission, one day flying it and a third day assessing their performance. Curtiss-Wright simulators are extensively used, and the scale of effort is revealed by a recent $600,000 contract for "simulator attendant supplies and services." (Conversely, it is worth recording that the fuel and oil bill for one hour of actual flying comes to $330.) Even mobile trainers for servicing crews represent a large outlay, and Boeing were lately awarded a $358,104 contract to modify those already delivered "to the configuration of the 88th airplane."

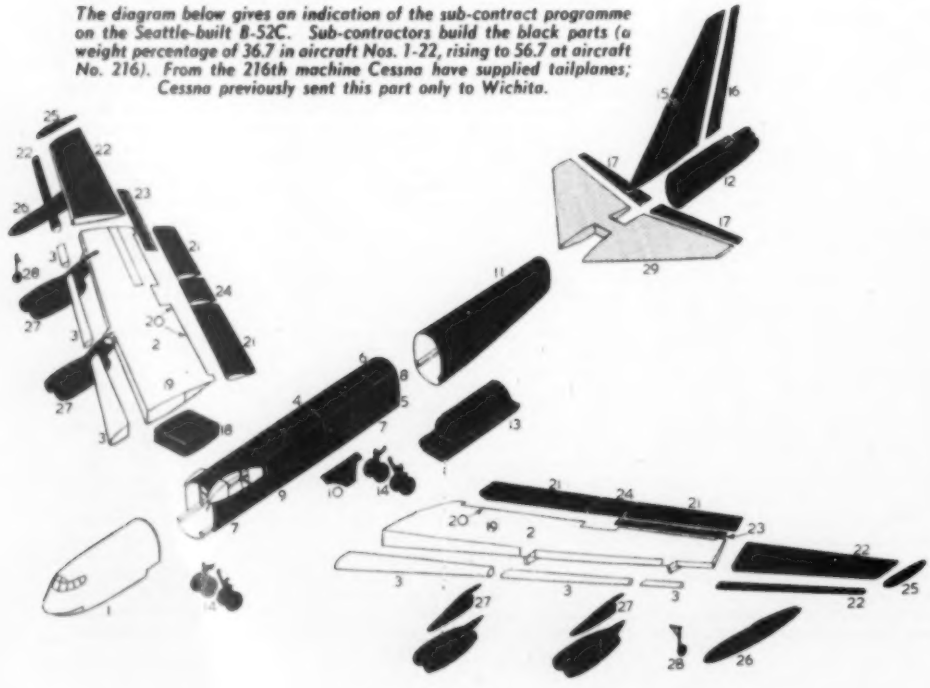
Maintenance of the B-52 is assisted by the care which has been applied to detail engineering, yet it is complicated by the sheer size of the aircraft. The flight-line of a complete B-52 wing is theoretically three miles long, which "puts the last airplane a long way from the hangar." Most work is done on the spot, and dozens of ground crew can sit comfortably inside the truck bays and under the engines in all kinds of weather, with all parts of the aircraft systems laid bare.

Engines are processed at Tinker A.F.B. (or by a civilian firm such as Pacific Airmotive), and the Oklahoma City Air Materiel Area had planned all such maintenance to the end of 1960 before the first B-52 was delivered. Major overhaul period on the J57 has risen from 500 hr in June last year to 1,000 hr, although few engines go the full life. Predominant cause of failure is foreign-object damage, although this is, at 20 per cent, half the usual U.S.A.F. figure. In the first full year at Castle 61 engines were "prematurely pulled," and the causes were: f.o. damage, 13; oil leaks, 8; high j.p.t., 8; turbine section damage, 7; nozzle guide vane damage, 5; oil-system malfunction, 3; miscellaneous, 17. Each "major" takes just over 1,000 man-hr, requiring 24 days on one-shift working, and the material cost averages $15,000 (reject rate is 3 per cent, except for blading which runs at 20 per cent).

Airframe overhaul is facilitated by the employment of universal trailers, by Air Logistics, provided with extending arms capable of lifting bomb doors, radomes and similar parts; with such a trailer two men can remove a complete flap section in 12 min. As a guide to ground staff, each aircraft wears no less than 4,000 deep-anodized coloured diagrams and instructional charts supplied by Metal-Cal.

Production of the B-52A and B-52B and their respective reconnaissance variants was terminated during 1955 in favour of the more advanced B-52C and D. Both these marks have under-wing tanks of considerably increased capacity (of the order of 2,500 Imp. gal) and more powerful J57-P-29W engines with a rating of almost 13,000 lb. The B-52D is equipped solely for bombing and is manufactured at Wichita. The first was rolled out in December 1955, flew on May 14, 1956, and was delivered to Castle A.F.B. in July of that year. The B-52C is the corresponding Seattle

The diagram below gives an indication of the sub-contract programme on the Seattle-built B-52C. Sub-contractors build the black parts (a weight percentage of 36.7 in aircraft Nos. 1-22, rising to 56.7 at aircraft No. 216). From the 216th machine Cessna have supplied tailplanes; Cessna previously sent this part only to Wichita.



Built by Boeing

1 Front fuselage
2 Inner wing
3 Inner leading edge

Sub-contracted

4 Fuselage fuel cells (Goodyear)
5 Side-panel assemblies (Goodyear)
6 Top-panel assemblies (Fairchild)
7 Landing-gear bulkheads (A. O. Smith, Kaiser)
8 Fuel decks and panels (Goodyear)
9 Bomb doors and panels (Aeronca)
10 Wheel-well doors (Aeronca)
11 Rear fuselage (Temco, Fairchild)
12 Aft fuselage (Rohr)
13 Reconnaissance capsule (Aeronca)
14 Landing-gear (A. O. Smith, C.P.T., Bendix)
15 Fin (Fairchild)
16 Rudder (Aeronca)
17 Elevators (Aeronca)
18 Wing stub-structure (Goodyear)
19 Wing fuel cells (Goodyear, Firestone)
20 Flap tracks (A. O. Smith, Rohr)
21 Flaps (Twin-Coach, Boeing Wichita)
22 Outer wing complete (Fairchild)
23 Spoilers (Aeronca)
24 Ailerons (Aeronca)
25 Wing tips (Zenith Plastics)
26 External fuel tanks (Rohr, Benson)
27 Struts and nacelles (Rohr)
28 Tip-protection gear (Fairchild)
29 Tailplane (Cessna)

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Powered by two Alvis "Leonides" Engines

Equipped for executive travel, seating is provided for six passengers.

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AERIAL SURVEY

The standard passenger version carries twelve, with baggage, facing forwards or rearwards. Stripped of seats, the cabin provides about 660 cu. ft. of freight space. Adapted for ambulance duties it can take six stretcher cases, while for air survey work provision is made for the use of all modern types of vertical and oblique cameras.

Developed from the Pembroke, the President offers commercial airline operators a truly versatile aircraft that can provide reliable, economic service in all its roles in both temperate and tropical climates.

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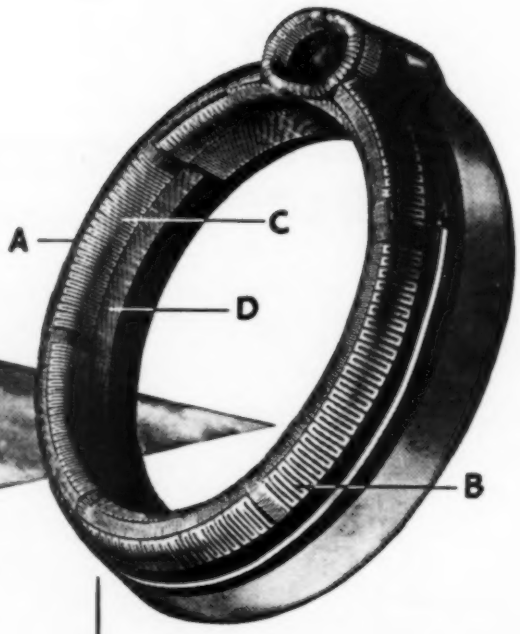
DUNLOP

THERMAL DE-ICING SYSTEM



increases safety and operational efficiency

For over twenty years Dunlop has been concerned with aircraft de-icing problems. Progress in aircraft design has demanded a new approach and a successful electro-thermal method of de-icing has been developed. It is based on the use of electrical heater circuits sandwiched between layers of rubber.

Heating of the circuits can be continuous or cyclic or a combination of both by means of a controller. Used with an ice detector, operation becomes fully automatic.

A DE-ICING SYSTEM with 3 important advantages

Dunlop thermal de-icing systems offer the following advantages:—
1. Effective removal of ice without disturbance of airflow.
2. Heat can be varied to give greatest protection at most vulnerable points.
3. Each circuit is "tailored" to suit its particular working conditions.

A further advantage is the ease with which circuits can be repaired if damaged.

The system consists of a lower layer of unvulcanised rubber which is applied directly to the metal surface of the aircraft. The heater circuit, cut or etched from nickel strip is then placed in position and covered by a second layer of rubber. The rubber is then vulcanised to give a surface resistant to climatic conditions and the effects of fuels and hydraulic fluids.

* *A typical application of a Dunlop thermal de-icing mat to the intake duct of a Rolls-Royce 'Dart' engine. Circuit A applies continuous heat of highest intensity to the leading edge of intake. Circuits B and C are cyclic in operation and apply a lesser degree of heat to areas adjacent to the leading edge.*
Circuit D again cyclically operated is situated further downstream of the intake and applies the lowest heat intensity.

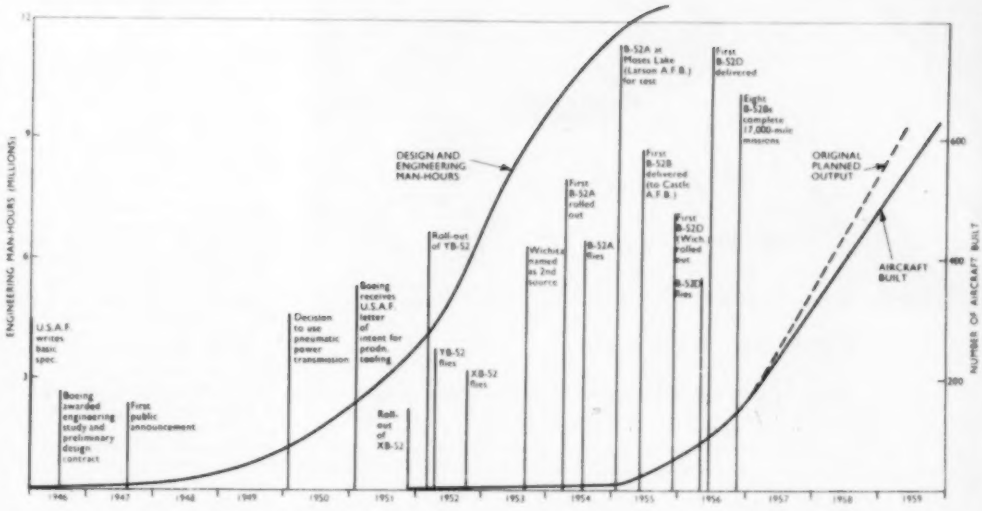
DUNLOP

De-Icing Systems meet the needs of the Aviation Industry

DUNLOP RUBBER COMPANY LIMITED · AVIATION DIVISION · FOLESHILL · COVENTRY

Boeing B-52 . . .

A progress-chart of B-52 development. The curves of engineering man-hours and aircraft delivered are approximate.



aeroplane and it is equipped to carry the reconnaissance capsule.

In the fiscal year 1957 (FY57) almost one-third of the procurement budget was devoted to B-52s, and the $2B brought the total cost of the aircraft, including research and development, up to $5.7B. At the beginning of 1956 a supplementary appropriation of $547m was provided to accelerate B-52 production from 17 to 20 aircraft per month to counter the threat posed by the Russian "Bison" heavy bomber. General Thomas D. White, then U.S.A.F. vice-chief of staff, said, "the Soviets have cut their lead-time on the Bison to just half what it has taken us to get the 52 off the drawing-board and into production." The resulting "crash programme" was aimed at completing the conversion of eight B-36 wings to the B-52 by the end of FY58 (i.e., June 30, 1958).

During 1956 the B-52 became thoroughly established in service, although secondary failures caused a number of disastrous crashes, particularly at Castle. One aircraft was lost near Travis A.F.B. in the winter of 1955. A second crashed early in 1956, and in this case it was ascertained that the turbine wheel in one of the Thompson turbo-alternators had disintegrated and caused one of the fuselage tanks to explode. In February 1956 all U.S.A.F. B-52s were grounded and 31 out of the 78 aircraft then produced were rejected. G.E. developed a revised turbine with titanium-alloy buckets weighing 0.03 oz held by a shear-pin and arranged to part from the wheel at 63,000 r.p.m. (23,000 above the maximum control speed) while being contained within their housing. At the same time the new AP-15 hydraulic pump was introduced, capable of operation at the same r.p.m. as the turbine shaft. It is worth noting that during intensive testing of the new turbo-alternator a single B-52 flew 174 hr 24 min during 21 missions in the month of May 1956.

In mid-September 1956 an electrical fault caused a fire and crash of another Castle aeroplane, and only the pilots escaped, the fire having disabled the warning systems. Late in that month a second grounding order was rescinded following a "rigid inspection of all internal systems." On November 30 came the third Castle crash, in which six crew-men and four instructors were killed; and the culmination came in December 1956 with two in-flight fires, both of which resulted in the loss of an aircraft, and a third machine which landed on fire and in which a complete hydraulic turbo-package blew out of the side immediately after touch-down. It was suggested at this point that the B-52 should employ fire-resistant hydraulic fluid, but the U.S.A.F. has so far not adopted this medium for combat aircraft. Rep. B. F. Sisk requested an investigation and the U.S.A.F. replied that the record of the B-52 was "grave, but not evidence of a defective weapon system." The U.S.A.F. Secretary, Donald Quarles, emphasized "the increasingly urgent need for this aircraft and for the weapons delivery mission it has repeatedly proven capable of accomplishing."

The B-52 dropped its first H-bomb on May 21, 1956, when an aircraft and crew from Holloman conducted trials at Bikini Atoll. Owing to a human error, the weapon missed its target by four miles, causing no small embarrassment at the A.R.D.C. establishment. It was revealed at that time that the procedure for dropping free-falling megaton weapons involved a maximum-speed dive from maximum altitude, followed by an automatically controlled 4g pull-up and Immelmann turn with release of the weapon during the climb; at detonation the B-52 is 20 miles distant. Completely successful missions were long-distance flights of some 17,000 miles around the N. American continent and over the North Pole by aircraft from Loring A.F.B. (42nd Bomb Wing) in November 1956, and a non-stop round the world mission of 24,325 miles by three aircraft from Castle between January 16 and 18 of this year.

Financial year 1958 brought a recession. On April 18 of this year Donald Quarles pointed out that production of 20 B-52s per month was "consistent with more than 11 wings" and it was decided to hold production at 15 per month until the total order for 603 aircraft had been completed. Reasons for so doing were given as: revised intelligence estimates of Bison production; progress with the Convair B-58 and other advanced weapon systems; the ability to deliver a higher proportion of "advanced" B-52s; achievement of the optimum manufacturing schedule; and a relaxation of the intense burden of training imposed on S.A.C. Accordingly, the FY58 order for 240 aircraft was cut to 101, so that by the end of June next year not 440 but 380 will be in service, with seven wings operational.

An S.A.C. B-52 wing has a basic strength of 45 aircraft (50 per cent more than the B-36 wings) and operates from three bases, two of which are limited-facility satellites each housing one squadron. The total heavy bomber allocation of eleven wings thus accounts for 495 B-52s. The total procurement of 603 is made up of 50 to allow for inspection and modification, 11 for test programmes and 47 to cover attrition due to unforeseen eventualities. The 603rd aircraft will be delivered towards the end of 1959, six months later than originally scheduled, but it may be decided in FY59 to increase the total number of B-52 wings from eleven to seventeen (Gen. LeMay at one time wanted 40).

Later models of the B-52 include the E and F (of which no details are available, but which are claimed to have 30 per cent greater range). The principal new mark, however, is the B-52G which has "a large wing containing integral fuel tanks" giving rise to the appellation "wet-wing B-52." The G is the subject of a model-improvement programme of August 1957 costing $12m at Wichita and $10m at Seattle. Other improvements include a vertical tail cut down by 20 per cent in area (owing to the success of the cross-wind gear), and installation of the J57-P-43W which is more powerful and is installed in an even more accessible manner. In addition, the G will carry the WS-131B long-range

Crew-comfort is of supreme importance on missions which may last 15hr or more. This photograph shows a B-52 co-pilot flying radio-range courses; points of interest include the schematic fuel panel and the octets of "poker chip" power levers and engine instruments.

A Boeing electronics engineer inspects a B-52D tail turret.

Boeing B-52 . . .

air-to-surface missile developed by North American specifically for this aircraft.

The advanced B-52G (aircraft No. 359) marks a complete breakaway from the pneumatic accessory-power system of all previous B-52s. It will be appreciated that arguments over mechanical and pneumatic drives have been protracted and heated, but the fact remains that the B-52G will be fitted with Sundstrand hydraulic drives transmitting shaft power from the engines to alternators mounted within the nacelles.

There has for some time been an increasing tendency in S.A.C. to aim at the complete elimination of all pneumatic ducting, and it is expected that the final batches of B-52Gs will have both electrical and hydraulic systems energized directly by the main powerplants in the conventional manner. Owing to the unavailability of a 60-kVA Sundstrand-driven alternator the rating of the Westinghouse units on the B-52G has been reduced to 40 kVA—apparently without compromising the capability of the aircraft. In the earliest B-52Gs removal of part of the pneumatic ducting within the wing has also facilitated extension of the tankage areas to conform to the integral concept of a "wet wing." It is certainly too early to attempt to assess the effect of the switch from pneumatic to hydraulic drives on the range and general performance of the aircraft. Tragically, a B-52 equipped with hydraulically driven alternators crashed at Tulsa early this year, but not for reasons associated with the new configuration.

Recently the U.S.A.F. accepted a Boeing proposal that the G should be assembled solely at Wichita. The company had their own reasons for proposing this, but it is also a logical and economical decision. Seattle will thus terminate B-52 assembly almost a year earlier than anticipated, and will then be free for other programmes. Bulk delivery of the G will start early next year, and at the 15-per-month rate it will be possible to equip three wings with the improved version.

Range of the B-52G without in-flight refuelling will probably be approximately 8,500 miles. Lt-Gen. Donald Putt, U.S.A.F. deputy chief of staff for research and development, recently suggested that laminarization and boundary-layer control could reduce the weight of the B-52 to about 90,000 lb, or some 400,000 lb less than the weight of a loaded G model. Sir Frederick Handley Page is more modest and suggests a reduction to 225,000 lb. This will certainly not be achieved in the life of the aircraft, for it is already becoming obsolescent in the face of three much later weapon systems.

These are WS-107, the ICBM (intercontinental ballistic missile); WS-110A, the C.P.B. (chemically powered bomber); and WS-125A, N.P.B. (nuclear powered bomber). U.S.A.F. money is at present pouring in a torrent into WS-107 and trickling gently into the other two programmes. The C.P.B. has the highest priority of any manned-aircraft programme for the U.S.A.F. and is progressing much faster than the nuclear aeroplane. Boeing and North American are the two contractors in competition for the C.P.B. and a decision is imminent. But if the ICBM continues to make satisfactory progress even WS-110 may never go into service.

A warm sun and gentle breeze ease the task of the engineers on the B-52C flight-line at Boeing Field, Seattle, Washington.

AIRCRAFT ELECTRICS

—by English Electric : New Test Laboratories Opened at Bradford

AMONG the facilities of the English Electric Co., Ltd., at its Phoenix Works, Bradford, are the new development laboratories of the company's aircraft equipment division, which were brought into full use last week. These laboratories, costing £500,000, have been constructed in two stages over the past three years, and include a wide range of environmental-test equipment.

Since its formation in 1954, the aircraft equipment division has concerned itself with a variety of aircraft electrical systems and components. It has produced improved D.C. equipment, but has concentrated mainly on the development of constant-frequency A.C. systems with the aim of reducing weight and improving performance, reliability and component life. The division's products currently include a range of constant-speed hydraulic drives, rotating electrical machines, actuators and control gear, in addition to complete A.C. and D.C. aircraft electrical systems.

A review of the division's progress was given, on the occasion of a visit to the Bradford factory last week, by Mr. P. J. Daglish, manager of the division, who said :—

"In 1954, as far as production was concerned, we were virtually only making actuators, and those for one aircraft only. Now we are making complete generating systems and have our equipment on eight different types of aircraft. We then held no contracts for the Sundstrand constant-speed alternator drive (which then formed the cornerstone of our future development policy for aircraft electrical systems) and it was being developed solely as a private venture of the company. Since then it has received Ministry of Supply support and is being installed in bombers of the Vulcan type.

"The constant-speed drives have been in production for over eighteen months and were closely followed by all the associated electrical equipment. Our present and future development policy is aimed at producing equipment able to withstand temperatures far in excess of present-day levels and at even higher altitudes. The equipment we have developed for the P.1 fighter is an example of this trend, where we have to accept very high ambient temperatures.

"We are developing novel forms of high-temperature insulating materials in conjunction with other research centres in the Group and will shortly have on test an alternator which has no brushes at all. A similar development, following the same philosophy of removing sources of trouble, is the evolution of so-called "static" control gear, where most of the moving parts are eliminated.

"To achieve all this, considerable expansion has been necessary over our original aircraft electrical section founded during the war. In four years we have increased our engineering team five-fold, whilst our production shops have nearly trebled their capacity. All told, approximately 1,000 people are now engaged on this work. . . .

"Electrical equipment has not always enjoyed a high reputation for reliability. I would suggest that this is because it has not had the same design and development effort put into it as have airframe or engines. And yet it is a fact today that in modern large aircraft, utilizing power-operated flying controls, the electrical system must be of a higher standard of reliability than the main engines. Without engines, given favourable circumstances, an aircraft can glide, but with no electrical power there is no means of operating the flying controls. . . .

"I believe the laboratories here are in advance of anything of their type in Europe, and compare well with any similar laboratories in the United States. We believe they have a great contribution to make in the development of reliable electrical equipment for aircraft, and we intend to see that this is done. . . .

"It is noteworthy that both the new Douglas and Boeing jet transports are using an electrical system very similar to the type we have developed here for R.A.F. aircraft. We believe that this system will find its way into future British civil aircraft and, meantime, we will be able to offer a comprehensive overhaul and replacement service to operators of the new American aircraft on this side of the Atlantic. In guided weapons we also believe we can make a contribution in this very specialized type of equipment and even now have some development work of this type in hand."

Commenting on the aircraft equipment division's design team, Lord Caldecote, a director of the company, said that one advantage which they possessed was that they were able to draw on all the research and development facilities of the Group. "Included in these," he said, "are the Nelson Research Laboratories at Stafford, the Mechanical Engineering Laboratories at Whetstone, near Leicester, and the Napier Research Laboratories at Acton.

"Concurrently with the building of these laboratories we have greatly expanded our production facilities. Here again we have taken full advantage of the resources of our Group. . . . All generating plant and control gear are made here in Thornbury Works, Bradford; actuators are made at a small sub-factory some six miles away, where the original Canberra actuator production was started; constant-speed drives are made at our Napier works at Netherton; and transformers are made at our Liverpool works. Development prototypes of all products, however, are made here in Bradford, and for this reason development shop facilities are being provided."

Part of the control room of the dynamometer laboratory, in which complete electrical systems for a four-engined aircraft can be tested.

The new laboratories have been designed to cover the development and type-approval testing of the complete range of aircraft and guided-weapon electrical equipment handled by the division, and a short tour of the premises indicated the comprehensive nature of the new facilities.

We first visited the dynamometer laboratory, where the complete constant-frequency A.C. power system of a four-engined aircraft was demonstrated. Four variable-speed drives, of 200 h.p. capacity, are employed. Each drive is double-ended and is equipped with step-up and reversing gearboxes. Output speeds are continuously variable from 200 to 12,000 r.p.m., using variable voltage supply from motor-generating sets. Automatic acceleration or deceleration is available at rates up to 1,200 r.p.m./sec, together with an overall electronic speed control to ± 0.1 per cent. A heated or cooled oil supply is available for four hydro-mechanical drives and, as indicated, a paralleled A.C. system for a four-engined aircraft can be simulated on each set of rigs. Both sets have electrical loading facilities up to 120 kW and 120 kVAR, 400-cycle, three-phase A.C. and also provide for hydraulic drive testing.

There are two high-altitude chambers in the new Bradford laboratories. The larger of these is a cylindrical chamber 9ft in diameter and 9ft long, which is used for the altitude testing of generators and alternators. A drive shaft leads into the chamber and can transmit 160 b.h.p. at speeds up to 24,000 r.p.m. Blast air is available at 20 lb/min at a simulated height of 60,000ft, with a temperature variable from -60 deg C to $+200$ deg C. It is possible to lower the pressure in the chamber to that at 90,000ft in 100 sec, and machines under test can be loaded electrically up to 120 kW. Inside the chamber at the time of our visit was a 20 kVA 12,000 r.p.m. alternator complete with voltage regulator and control system; the test in progress was a check on voltage regulation, at 30,000ft and 15 deg C ambient, over a range of electrical load switching from zero to maximum.

Measuring $3\frac{1}{2} \times 3\frac{1}{2}$ft, the small high-altitude chamber gives a temperature range from -85 deg C and altitudes up to 80,000ft. Associated with these two chambers are a sea-level cold chamber (temperature range from -60 deg C to ambient) and a diesel house containing two diesel-engine-driven test rigs which are used for D.C. and low-capacity A.C. systems.

In the actuator test laboratory there is provision for a range of rotary and linear actuators. Hydraulic, compressed-air and dead-loaded rigs are used for linear actuators, and there are five friction-type rigs for the rotary units. This laboratory includes a screened room with calibrated receivers for the testing of radio-interference suppression.

The general machine-testing laboratory concentrates largely on

Left, a general view of the high-altitude test laboratory, with small chamber in foreground and heat exchanger on right. In the main chamber (right), final adjustments are made to a 40 kVA alternator prior to testing.

AIRCRAFT ELECTRICS . . .

D.C. generator testing, a 30-volt loading being provided up to 15 kW. Both A.C. and D.C. motors up to the largest sizes envisaged for aircraft can be handled, and starter test rigs are also available.

Equipment in the vibration laboratory includes three Moy mechanical tables, each capable of applying circular vibrations to equipment weighing up to 25 lb and over the frequency range 0-150 c/s; and a de Havilland moving-coil type transducer capable of applying linear vibrations at frequencies up to 500 c/s to equipment weighing up to 120 lb.

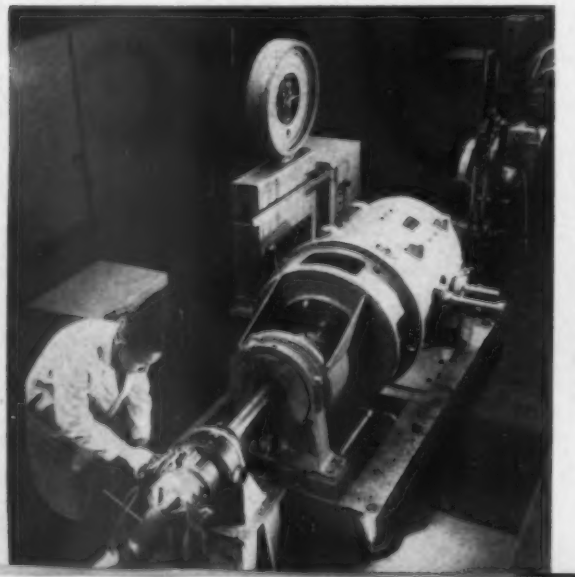
The effects of *Aspergillus Amstelodami* on a Type 98 voltage regulator might sound an improbable sort of thing to investigate, but this was one of the tests taking place in the climatic laboratory at the time of our visit. The resistance of various electrical units to attack by the above-mentioned and other tropical fungi was being studied in one of two small chambers, in which the units were being kept for 28 days at a time, at 32 deg C and 95 per cent humidity. A transformer rectifier unit was undergoing simulated tropical exposure testing in a second humidity chamber, and a control panel was being alternately heated and frozen in the main panclimatic chamber. This measures 3ft × 3ft × 3ft, and its range of test conditions comprises temperatures from −65 to +70 deg C, humidities up to 100 per cent and simulated altitudes up to 60,000ft. Two large ovens, controllable to 200 deg C, are used for long-period, high-ambient tests on smaller pieces of equipment.

In the acceleration and explosion laboratory, two explosion chambers are used for the flameproof testing of components. An explosive mixture of iso-pentane is introduced into the chamber in use, and a spark is generated inside the case of the unit under test. The gas inside the component should ignite, but that in the rest of the chamber should not. Other equipment in this section includes a centrifuge capable of applying between 6 and 20g; and a shock-test machine capable of 25g.

Other departments of the new laboratories are concerned with control-gear development; hydraulic components; investigation of new materials, bearings, insulation, etc.; measurement problems (e.g., frequency transients, airflow, humidity); and endurance testing.

An interesting tailpiece to our Bradford visit arose from the sight of a large wing-rib hanging on the wall of one of the laboratory offices. This had been found a few months ago, together with a four-bladed propeller, during the re-building of the works to accommodate the new laboratories. The spruce rib, it transpired, belonged to one of the Phoenix P.5 Cork flying boats designed and built on these premises at Bradford by the Phoenix Dynamo Manufacturing Company some 40 years ago.

Left, an aircraft alternator being connected on a dynamometer test rig. Right, checking a 300-amp wide speed-range generator in the inspection and test department of the aircraft equipment division.



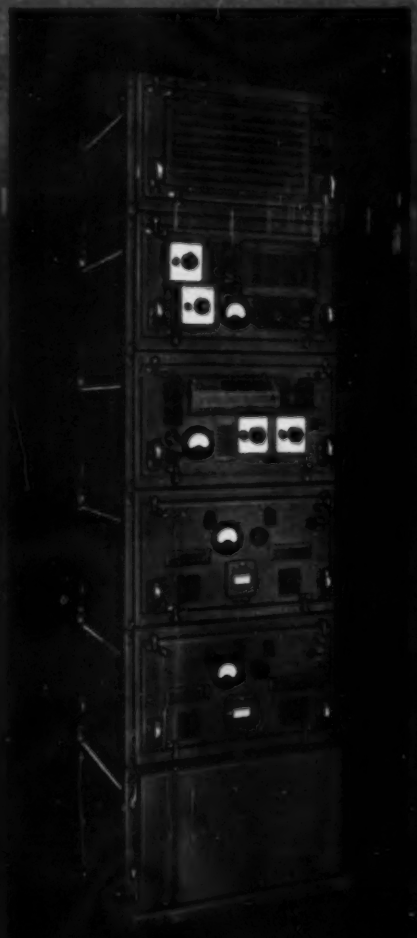
Top level achievement in UHF equipment

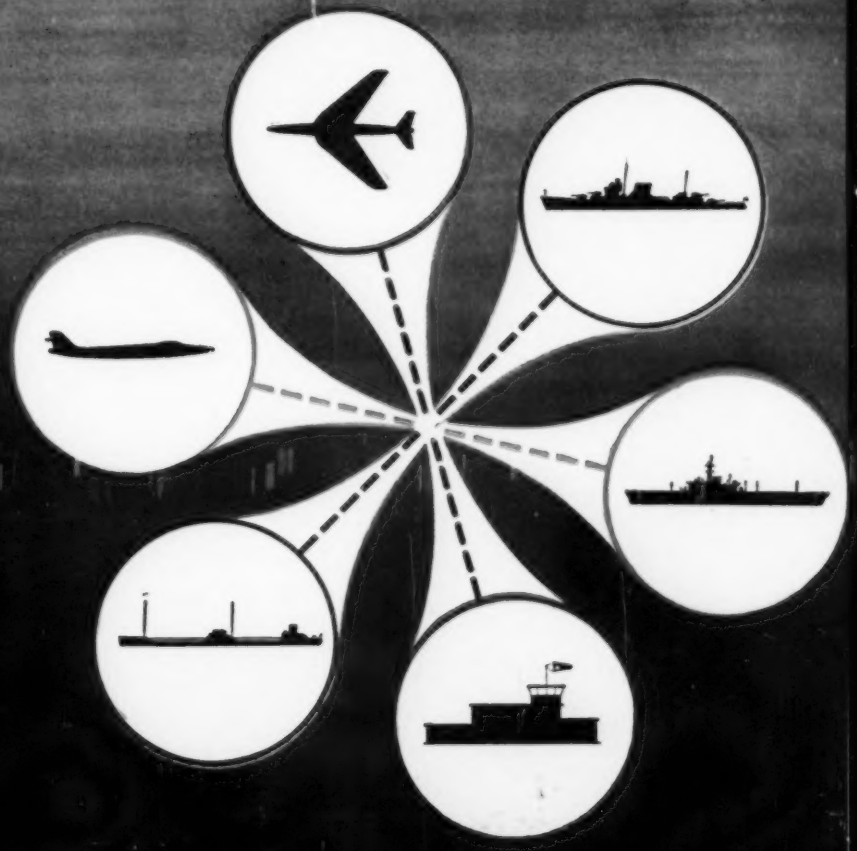
That both the Royal Navy and the Royal Air Force have already accepted UHF by Plessey as standard equipment, bespeaks well its advanced conception and practicability. It has been adopted as standard equipment by the British Services for ground-to-air and ship-to-air communications and is now in large scale production. In addition it can be used for point-to-point, ship-to-ship, and ship-to-shore working.

This new UHF radio telephone communication equipment provides 1750 channels in the range 225/399·9 Mc/s and is available in single or multi-channel versions for Air Force ground stations and in special cabinets for ship fitting.

An outstanding feature of this system is that many of its sub-units are common to, and interchangeable with, several versions of the equipment. This Plessey UHF equipment will operate with any standard UHF Airborne sets currently in use or envisaged for NATO Forces.

Remote control facilities can be provided for either land or shipborne use.





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From a painting by Roy Cross

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THE INDUSTRY'S DILEMMA

A Review and Some Practical Suggestions: Lord Weeks' Address at Air League Luncheon

IN our news pages last week we reported salient points from the forthright speech delivered by Lt-Gen. Lord Weeks of Ryton. Lord Weeks, who is a director of Vickers, Ltd., parent company of Vickers-Armstrongs (Aircraft), Ltd., was speaking at an Air League luncheon on November 4 at the Mansion House, with the retiring Lord Mayor of London, Col. Sir Cullum Welch, presiding. We now give a more detailed report.

After commenting on the fact that the aircraft industry "has to conduct its affairs in the full glare of public opinion," and remarking that, in view of the risk of damaging British prestige abroad, Ministers and others should abstain from making technical prophecies and that airline operators should refrain from public criticism of their suppliers (and *vice versa*), Lord Weeks said:—

"The first point I want to make is really a follow up of some of the comments that Lord Swinton made a year ago, in connection with the organization of the Service and other Ministries, and in particular his recommendations for a Minister of Defence with (as he put it), real and effective power over all the Services. Now this recommendation has to a large degree been accepted; you have a Minister of Defence with greater powers and you have had a White Paper which has evolved from his creation. I wonder how much you like it?

"The theory of organization of the defence Services and Supply, and of their possible integration, is something on which it is difficult to keep individual blood pressures at a low level. It is a highly contentious subject, and the main difficulties in arriving at a real solution are: (a) that the people who should be thinking have not really got time to think; and (b) that the kind of defence that we have to provide for is difficult to forecast.

"In ten years' time, whether it will be a guided-missile era or a ballistic missile era, where will the responsibility lie? I may add: who will be responsible for 'space' technology? We have had enough to shake us in the last 24 hours [a reference to the launching of Russia's second satellite—Ed.]. I find it hard to believe that in ten years' time we shall need a large War Office, a large Air Ministry and a large Admiralty. The Ministry of Supply occupies the extraordinary position of being interposed, especially as regards the Army and the R.A.F., between the user and the industry which has to make the equipment; and it has very few friends.

"If there is any truth whatever in the accusation that the aircraft industry has been feather-bedded in the past, it is partly due to the policy of the Ministry of Supply. Having worked with it from outside as an industrialist, and alongside and partially in it during the war, I feel it is the wrong conception, though I acknowledge the excellent work and ability of some of the highly qualified technical people in the Ministry.

"I can only suggest that somebody should endeavour to work out what realignment of responsibility and organization should be adopted to cover the Services and their supply—starting with the Minister of Defence as the focal point. The accent should be more on overall defence self-sufficiency and not so much on Service self-sufficiency."

White Paper's "Faulty Conclusions"

Returning to the subject of the White Paper, which he characterized as "a courageous document" in that it faced the economic facts, the facts of the H-bomb, and the technical facts implicit in rocket progress, Lord Weeks said he believed that the conclusions drawn from those facts would eventually be proved faulty in a few vital respects. "The White Paper," he continued, "has hit the Services very hard, in all sorts of ways; and as far as the aircraft industry is concerned it has given us a signpost along a very desolate road. Just what we are up against in the industry, both from a military and a civil angle? First, in the military field:—

"(a) A reduction in the total money to be spent on research and development—which means a cut as far as the industry is concerned.

"(b) The abandonment of further supersonic bombers—a further cut in the industry.

"(c) The supersession of fighter aircraft beyond the P.1 by guided missiles; again an alteration in the impact on certain parts of the industry.

"(d) The development of ballistic rockets—which may help only certain specialized parts of the industry."

Lord Weeks said that his principal comments on these four factors were:—

"(a) The aircraft industry cannot exist in a competitive world without adequate funds being allocated for research and development.

"(b) As regards supersonic bombers, I don't know what can defeat a low-flying supersonic bomber, so I hope a reprieve may be possible.

"(c) In the case of the supersonic fighter, and also the supersonic bomber, if the opinion of the aeronautical correspondent of *The Times* (on October 17) is correct, it does appear that some sort of reprieve is contemplated: he mentions the probability of a specification for an operational aircraft of advanced design for either Fighter or Bomber Command. He also states that an interesting condition, believed to be attached to this invitation to tender, is that two or more firms should co-operate in the design and development.

"I think the timing may be too optimistic and that the manned aircraft may still have a long life ahead of it; in the present programme there is, in my view, a danger that the overlap between the exit of the manned aeroplane and the entrance of the guided missile may be too short."

Turning to civil aircraft, the speaker quoted the White Paper:

To be effective, the Central Reserve must possess the means of rapid mobility. For this purpose a substantial fleet of transport aircraft is being built up in R.A.F. Transport Command.

"This," he continued, "is an implied promise; I hope it will be implemented by ordering the best aircraft for the job. The Government always strongly asserts that it believes in a strong aircraft industry. If it does, it must not run away from the consequences and ensuing responsibility."

Civil Aircraft and Transport Command

Lord Weeks then enumerated "some of the difficulties that we are up against in the civil field":—

"(1) The United Kingdom—a British David—is up against a Goliath—the United States—from the point of view of resources and utilization. The U.S.A. has a domestic civil market equal in operating capacity to all the rest of the world's scheduled airlines put together. I equally know that the American aircraft industry is up against a difficult time also.

"(2) The U.S. aircraft industry in 1956 was the largest employer of labour of any manufacturing industry in the United States, and it operates on the back of enormous government orders. The total output of civil aircraft in 1956 was only about one-eighth of the total turnover, and civil aircraft are bought in large numbers by the military. If my figures are correct, the military Air Transport Service flew 1.2 million hours in 1956; I don't know Transport Command hours, but they must obviously have been minute by comparison.

"(3) The provision of finance for the development of a new civil aircraft assumes such large figures that few firms are capable of tackling it. It is also very unfortunate that the financial position of world airlines, partly due to the fact that no one has the guts to raise fares, is deteriorating at a time when it must find enormous amounts of new capital to finance the jet age.

"(4) Export sales more often than not depend on some sort of credit system or arrangement, as very few operators are flush with cash. In this respect the Export Credits Guarantee Department of Her Majesty's Government wants a real shake-up to enable business to be done at greater speed, and I suggest it should take a broader view of the risk element.

"In spite of all this," continued the speaker, "I start from the conviction that we are skilful and able enough to hold our own in what is one of this country's most vital industries."

After touching on several miscellaneous topics, including the possibilities for VTOL and supersonic airliners, and the status of the Corporations ("I am entirely in favour of increasing the proportion of traffic which could be allocated to the independent companies") Lord Weeks returned to the immediate problems of aircraft constructors. They were faced with a variety of courses:—

"The years of experience which are required to build up a civil aircraft business, together with the great financial resources and skilled manpower and other facilities, mean that probably only about three U.K. firms can compete in the world's civil markets for medium to large aircraft with any hope of getting orders.

"The first and proper course could be amalgamation, which could involve grouping and/or absorption of some of the smaller units by their bigger brothers, as far as airframe construction is concerned.

"In any contemplated amalgamation it is essential to strengthen by every possible means those parts of the industry which have shown themselves capable of earning exports. The work must go perhaps to those who are 'too busy to do it' rather than to those who can't get anything else. Someone has got to ensure that our technical resources in men and equipment are properly used and that the brains are in units which have the equipment and finance ready to use them fully.

"Amalgamation and/or absorption must, therefore, be highly selective, and should also apply to the engine makers. I have a feeling that an aircraft constructor should not be an engine constructor.

"A second alternative is a sort of half-way house by which a combination of companies get together to carry out a project; it is a step, but cannot be the ultimate goal.

(Concluded at foot of page 786)

SERVICE AVIATION

Royal Air Forces and Naval Aviation News

Sir Thomas Pike

THE following Royal Air Force promotion, to take effect from November 1, 1957, is announced: Air Marshal to Air Chief Marshal, Sir Thomas G. Pike, K.C.B., C.B.E., D.F.C., Air Officer Commanding-in-Chief, Fighter Command.

Victors for the R.A.F.

FOLLOWING handling trials at Boscombe Down, an operational conversion unit for Handley Page Victor bombers will shortly be formed at Gaydon.

Pinecastle Results

WINNERS of the Strategic Air Command bombing and navigation competition at Pinecastle Air Force Base, Florida, which ended on November 5, were the 321st Bomber Wing of S.A.C., a B-47 unit normally based at Pinecastle. The two R.A.F. Valiants of No. 3 Group were placed 27th, and the two Vulcans of No. 1 Group 44th, out of 45 entries. In the individual-crew results, Valiant XD861, captained by S/L. Ronald Payne, came 11th in the combined bombing and navigation category, out of a total of 90 crews. S/L. Payne's crew comprised S/L. Donald Collier, bomb-aimer; F/L. George Bridson, navigator; F/L. Gordon Harper, co-pilot; and Master Signaller Eric Brown. The crew obtained 222 points out of 250 for navigation and 626 out of 750 for bomb-aiming, the final placings being decided on the total of these two sections. The bombing section was won by the B-47s of the 384th Bomber Wing, and the navigation section by the B-36s of the 72nd Wing. In bombing alone the Valiants were placed 23rd and the Vulcans 45th; and in navigation the Valiants were 30th and the Vulcans 34th. The second Valiant crew consisted of F/L. Roy Mather, captain; F/L. Kenneth Bruton, bomb-aimer; F/L. Peter Cole, navigator; F/O. Donald Ross, co-pilot; and F/O. George Stratford, air signaller. Their aircraft was XD859. On an individual-crew basis the second Valiant was placed 75th, and the two Vulcans 81st and 84th.

At a conference following the competition, Air Chief Marshal Sir Harry Broadhurst, C-in-C. of Bomber Command, said that the R.A.F. aircraft had done as well as he had expected, in view of the tremendously high standards of the S.A.C. crews. The results pointed to the fact that the crews with the aircraft which had been longest in operation had the best scores, he continued. Valiants had been in service only since 1955, and Vulcans only since May of this year. They had been preparing for the S.A.C. contest with their complete equipment since August.

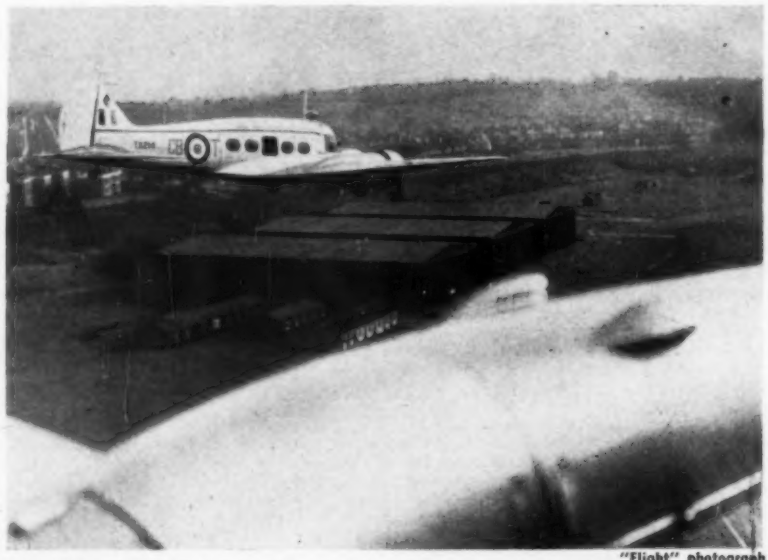
"The results have rather hinged on the experience of the ground crews in maintaining the equipment and the air crews in using it. I have the feeling that humidity has been affecting the Vulcan more than anything else. But the relative experience of the ground crews in maintaining the equipment must tell."

Asked whether the R.A.F. had any equivalent to the Rascal air-to-ground missile of S.A.C., Sir Harry said that the so-called stand-off bomb, a missile comparable to Rascal which was being built by A. V. Roe, would be tailored to suit the Vulcan.

After flying back to this country as co-pilot in a Vulcan—the flight from Washington to Marham took 6 hr 16 min, corresponding to an average speed of 582 m.p.h. —Sir Harry said that the Vulcans could operate higher than any U.S. bomber aircraft. The R.A.F. entry in the bombing contest, he added, had been handicapped by being restricted to an operating height of 30,000ft.

"Flight" photograph

Air Marshal Sir Andrew McKee, K.C.B., C.B.E., D.S.O., D.F.C., A.F.C. (third from right), photographed with members of the R.A.F. Metropolitan Communications Squadron outside the Officers' Mess at Hendon on November 7 (see also picture above). On the extreme right is G/C. P. W. Stansfeld, C.B.E., D.F.C., Station Commander, R.A.F. Hendon, and second from right W/C. K. C. Roberts, W/C. Flying. Third from left is S/L. K. L. Hughes, A.F.C., Commanding Officer, Metropolitan Communications Squadron.



"Flight" photograph

Last flight out of Hendon, on November 7. The Anson of R.A.F. Transport Command's Metropolitan Communications Squadron is en route for its new base at Northolt and is seen from a Devon. The eventual use of Hendon by STOL and VTOL aircraft is envisaged.

Future Naval Aircraft

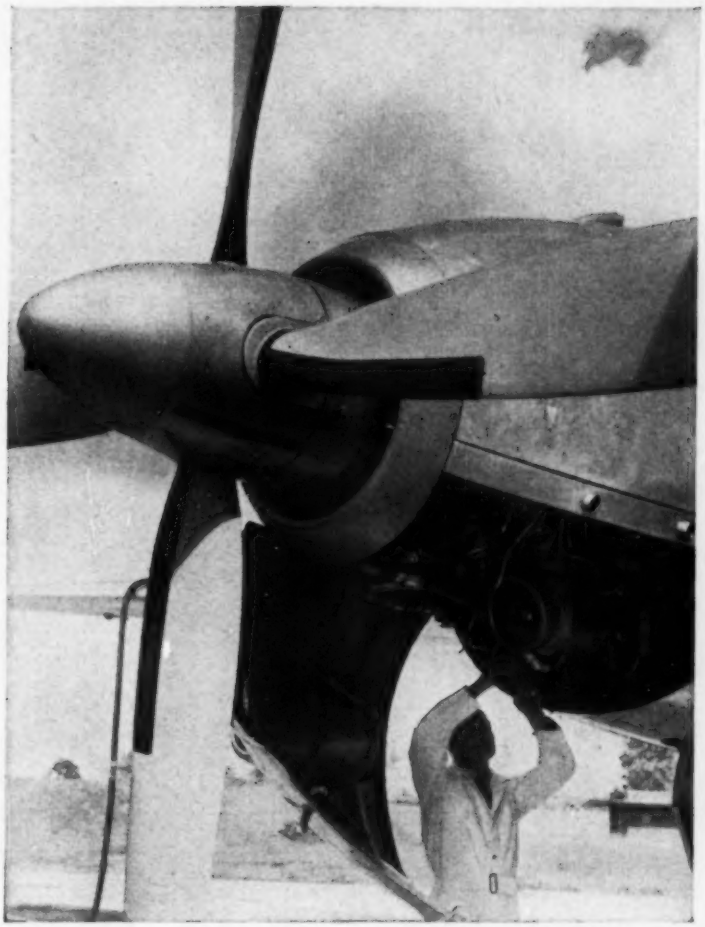
TACTICAL employment of new Naval aircraft shortly to enter service was the subject of a two-day conference which took place at R.N. Air Station, Lee-on-Solent, last Monday and Tuesday, November 11 and 12. Senior officers of the Ministry of Supply and of aircraft firms, and a large number of Naval officers, attended the meeting. By outlining the strategy prompting Admiralty requirements, and describing the aircraft being designed by aircraft manufacturers to meet these requirements, it was intended to give Fleet Air Arm officers an appreciation of the close relations necessary between the companies, the M.o.S. and the Admiralty.

Bomb-loading Award

AN award of £1,500 for inventions to simplify the loading of bombs on the Canberra, Victor, Vulcan and Valiant has been received by an unnamed officer of R.A.F. Station Lindholme. The award is one of the highest yet made by the Royal Commission on Awards to Inventors to a serving officer.

898 Change Over by Helicopter

FOR the third time in its history, 898 Squadron (Lt-Cdr. D. B. Morrison, R.N.) has transferred with all maintenance personnel, stores and baggage from one carrier to another by helicopter. The transfer from *Ark Royal* to *Bulwark*, which took place in Falmouth Bay, came near the completion of recent routine day and night flying exercises held in the western part of the English Channel. The flying of the four Whirlwinds was shared by Lts. K. Mitchell, R.N., R. H. Williams, R.N., and G. A. Bagnall, R.N., from *Bulwark*, and Lt. D. F. Myers, R.N., and Sub-Lt. R. A. Lister, R.N., from *Ark Royal*. They made 56 sorties in 65 min and moved 88 officers and men and 30 tons of stores and personal baggage. As usual when "changing their home," bowler hats were worn by squadron pilots when entering and leaving their Sea Hawks.



Quicker, Simpler

(and that means CHEAPER)

maintenance with the ELAND

EFFICIENT AIRLINES are thinking more and more in terms of propeller turbine propulsion for short and medium haul services. In this field the Napier Eland has a number of outstanding advantages, among them being its extremely low maintenance costs.

CHEAPER ON THE GROUND

The Eland engine consists of four main sub-assemblies: reduction gear, compressor, combustion chambers and turbine. Each sub-assembly is a self-contained unit that can be removed and tested separately. This type of construction makes for easier and quicker maintenance and gets the maximum working life from each component.

CHEAPER IN THE AIR

The Eland is designed for economy. A Convair with piston engines will carry a full payload 250 miles, but the same aircraft, after conversion to Eland engines, is able to extend its range to 970 miles and increase its speed by 55 m.p.h. The extra 2,000 h.p. that is developed by the Elands enables the same aircraft to carry its full payload under operating conditions of extreme temperatures and altitudes. This economy and flexibility can be expressed in substantially lower operating costs.

PASSENGER APPEAL

Passengers need no technical knowledge of aircraft to form stubborn preferences. Once they have experienced (or been told about) the smoothness and quietness of turbo prop flight, they will avoid travelling by piston engined aircraft whenever possible. In addition, the greater simplicity and reliability of the turbo prop engine are factors that weigh heavily with the passenger and influence his choice of airline.

TO BUY OR CONVERT?

While the final decision depends on a number of variables—such as the life of the aircraft, its book value and its revenue earning power—it is almost always sounder economics to convert an existing piston engined machine than to buy a new airliner. An Eland conversion can be carried out for less than a third of the cost of a new aircraft with the certainty that this expenditure will be quickly recovered by the increased earning power.

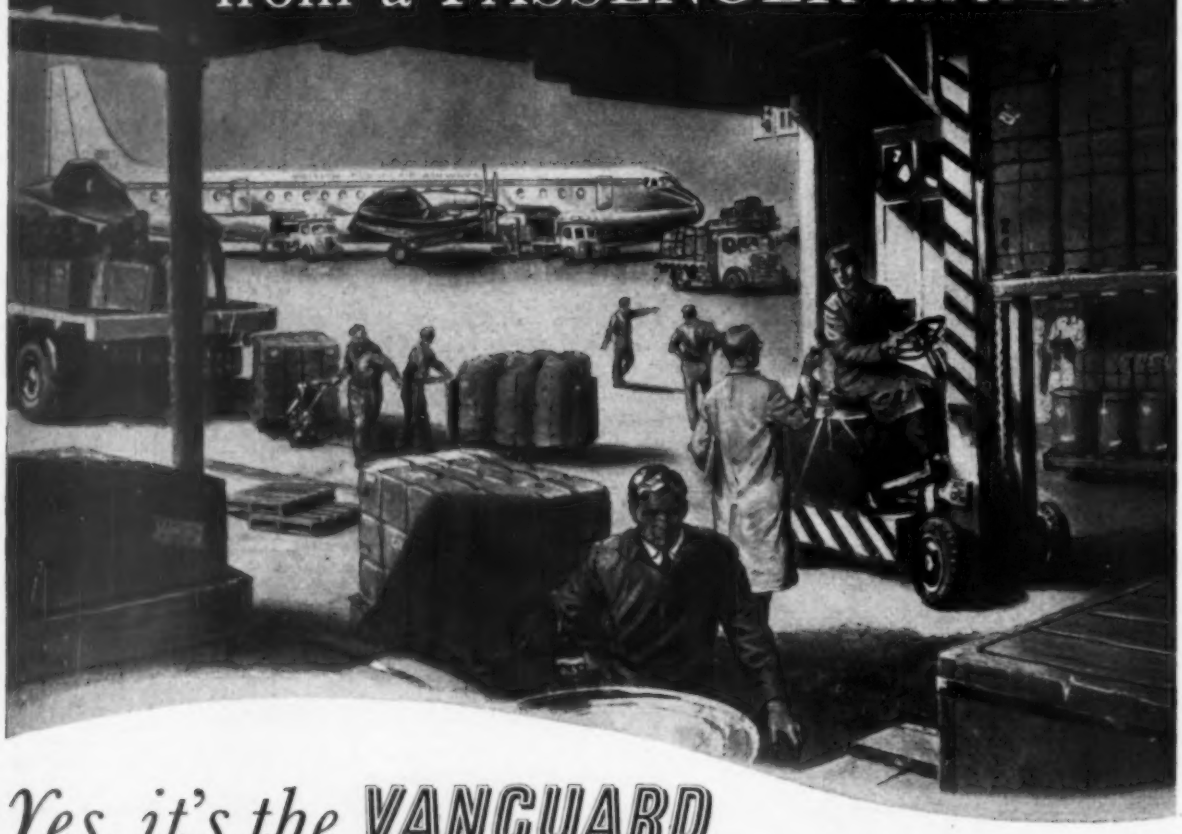
the era of the ELAND is beginning

D. NAPIER AND SON LIMITED, LONDON, W.3

NAPIER

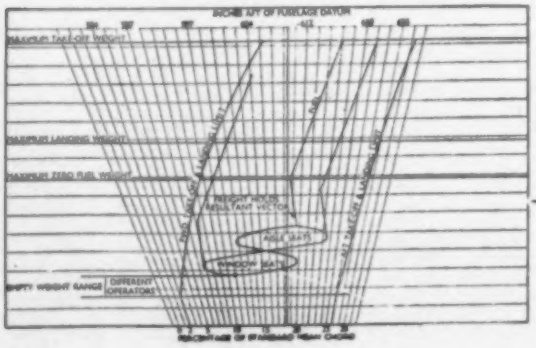
CBC 831

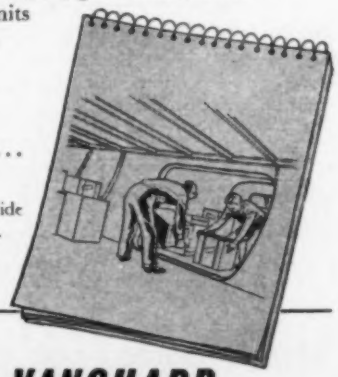
All this FREIGHT from a PASSENGER aircraft?



Yes, it's the VANGUARD

The ability to carry up to 120 passengers or ten tons of freight (density 15 lb. per cubic foot), will ensure profitable operation of the VANGUARD, winter and summer, day and night — even when passenger traffic is at its lowest ebb. With a combined capacity of 1,360 cubic feet, the two spacious holds in the 'double-deck' fuselage give ample room to arrange the freight conveniently in separate destination groups. The exceptionally wide freight doors, situated on the side opposite the passenger doors, give unobstructed access for simultaneous loading and unloading. The very wide C.G. range permits maximum flexibility of passenger and cargo loading. The 'loading loop' below shows the ideal matching of the C.G. limits which is possible with the Vanguard — yet another reason why the Vanguard is the airline's airliner.





For your notebook...

Each freight hold has an unobstructed access 5ft. 6in. wide and 3ft. 10in. projected height. Headroom inside is 4ft. 3in.

VICKERS VANGUARD

Four Rolls-Royce Tyne Propeller-Turbine Engines

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT518

CIVIL AVIATION

THE BRITANNIA ACCIDENT

IT is with great regret that *Flight* records the accident which occurred at Bristol on November 6 to the Ministry of Supply's Bristol Britannia 300 prototype, G-ANCA, resulting in the deaths of all 15 of those on board.

The aircraft was returning to Filton airfield just before noon after making an apparently normal test flight. According to reliable eyewitness accounts, it seems that after making a routine turn to port in a position to the south-east of the airfield at about 1,500ft, the aircraft swung away to starboard, went into a steep turn, lost height, and struck the ground four miles from the runway. The Britannia was almost completely destroyed and considerable damage was caused to a row of houses.

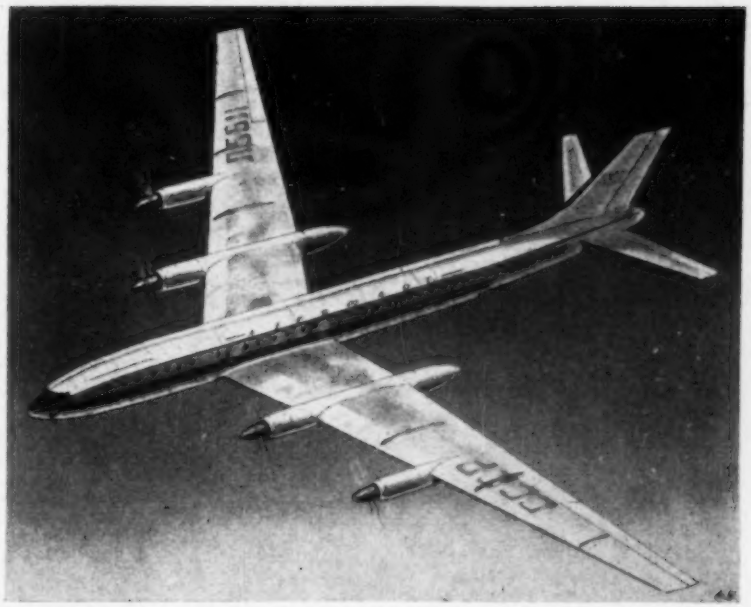
The pilot was E. H. Statham, Bristol's assistant chief test pilot, and the co-pilot was S/L. D. M. Hunter, R.A.F. Transport Command liaison officer. The Bristol personnel were W. J. Todd, radio officer; D. C. Cameron, flight engineer; J. H. Parry-Jones, systems engineer; F. W. Mycroft, junior technical engineer; N. M. Thorne, photographer; P. N. E. Hewitt, senior technical engineer. Also on board were personnel from de Havilland Propellers, Ltd., and Redifon, Ltd. From D.H. were J. E. Burton, a section leader in the strain-gauge department; A. E. Ebling, a tester in the same department; and D. N. S. Moynihan, development engineer. The Redifon personnel were J. K. Barker, F. C. Walsh and K. G. Lucas, all electronics engineers. Also on board was B. F. Waite, photographer and writer.

The Bristol Aeroplane Company stated after the accident that, so far as anything could be said with certainty at that time, the aircraft was not—as some witnesses said—on fire in the air. Mr. Harold Watkinson, Minister of Transport and Civil Aviation, stated in the House of Commons on November 7 that a "detailed and exact" investigation by the Chief Inspector of Accidents would be held. B.O.A.C. decided that, pending fuller information, the second transatlantic proving flight which their one Britannia 312 G-AOVB was about to operate would be deferred. However, the aircraft left on its proving flight last Saturday, when it had been established that there was "no obvious reason" why the proving programme should be further delayed. Similarly, El Al's second proving flight from Tel Aviv to New York *via* London was due out of London last Tuesday. So far as could be ascertained as *Flight* went to press, each airline's plans to inaugurate scheduled transatlantic services remain unchanged—that is to say, B.O.A.C. hope to start services "within the first three months of 1958," and El Al "before the end of 1957." Each airline intends to carry out a number of proving flights, the precise number depending upon experience gained.

There is, at the time of writing, no indication as to the cause of the accident to G-ANCA, which was the first to a Britannia involving loss of life. A night-and-day examination of the evidence continues—the parties involved (directly or indirectly) being the M.T.C.A., Bristol, the Ministry of Supply, and the Air Registration Board.

The Bristol company have said that the aircraft was jettisoning fuel before it struck the ground, which might explain the eyewitness reports of fire in the air. It is understood that the possibility of faulty flap-operation is now considered unlikely. Film from the automatic instrument recorder was salvaged from the wreckage, but we understand that it provided no useful evidence.

A memorial service will be held in Bristol Cathedral on Tuesday, November 19, at 12 noon, in memory of those who lost their lives in the accident. The service will be open to all friends who wish to attend.



This "Flight" artist's impression of the Tu-114 is based upon the photograph in side-view which we published last week, and upon the known double-sweep wing plan-form of the Bear bomber. Relating the length of the nacelles to those of the Bear, and drawing a construction line between the wing tips—both of which were visible in the photograph—determined the probable proportions of the Tu-114. The engines are reported to be Kuznetsov NK-12-Ms—"twice as powerful as similar foreign engines."

STOCKHOLM'S FUTURE AIRPORT?

IT seems that at last a solution has been found to the problem of finding a new international airport for Sweden's capital. After negotiations between the Swedish Minister of Transport, representatives of AB Aerotransport (shareholders of the Swedish interest in S.A.S.) and S.A.S., it was suggested that the airport at Halmsjön be developed for international traffic, and the present one at Bromma retained for domestic traffic.

Mr. A. Rusck, president-elect of S.A.S., said that although the airline regretted very much that no other solution could be found, he hoped that the government and parliament would adopt the one suggested.

Halmsjön is to be partly completed by the beginning of 1960, when the first DC-8s are delivered to S.A.S. By 1963, facilities will be in operation and there will be a new road link to the city. To assist AB Aerotransport in building the necessary maintenance facilities at Halmsjön, the company is to be lent £4.5m by the government.

AUSTRALIAN OUTLOOK

WITH the sale to Ansett of Australian National Airways, and with Trans-Australian Airlines the only domestic airline to operate at more than a marginal profit, the Australian Government recently made a comprehensive survey of civil aviation to find causes and remedies for the "not very rewarding" condition of the domestic air transport industry. T.A.A. made an operating profit of £A308,829 in last year's operations, but the Government is subsidizing other airlines' development services to the tune of £A350,050 a year (it will be more with extended support for feeder services) and £A7m is being spent on ground services, with a revenue from fuel tax and air navigation charges of only £A2m.

Senator Paltridge, the Minister for Civil Aviation, said recently that recurring financial crises were caused by the inability of the DC-3 to provide Australian operators with profitable returns, and because there was an overlapping and duplication of services on certain trunk routes. He proposed to eliminate this unstable situation by subsidizing operators of essential rural services and assisting selected operators to replace their DC-3s with aircraft "like the Herald and the Friendship." Funds would also be pro-

Among the new turbine transports to fly in the next few months, is the Comet 4. Here the fuselage of the fourth aircraft is being moved into the equipment bay.

CIVIL AVIATION . . .

vided in certain cases for the progressive acquisition by the Commonwealth of country aerodromes. Elimination of uneconomic competition on the trunk routes was the intention of the 1952 Civil Aviation Agreement; but since this was not working very well in practice, the Government proposed to strengthen the "rationalization" provisions of the act.

EAGLE VIKING REPORT

FINDINGS, published last week, of the public inquiry into the accident to the Eagle Aviation Viking G-AJBO at Blackbushe on May 1 show that the Commissioner attributes the cause to "an error of skill and judgment" made by the captain.

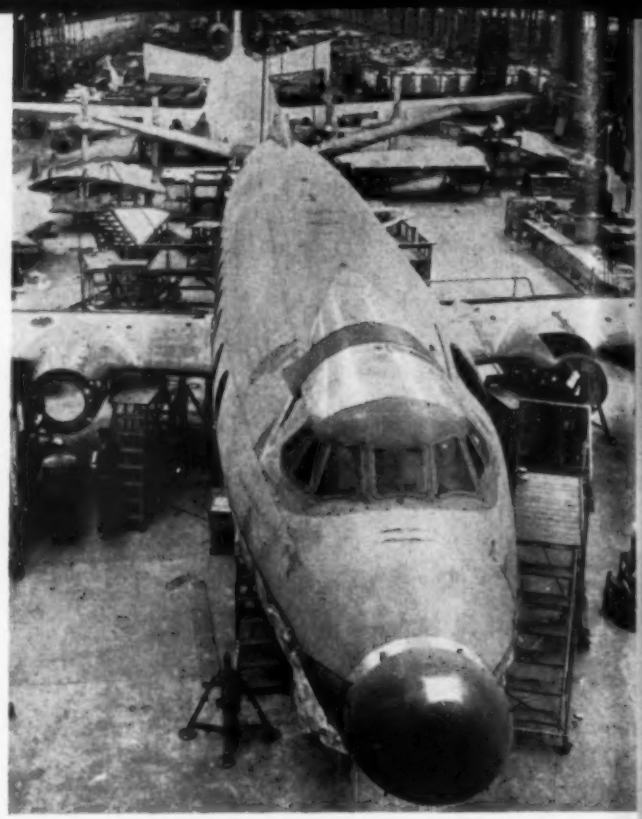
The accident to Bravo Oscar occurred at 2220 hr B.S.T. shortly after the aircraft had taken off from Blackbushe on a trooping flight to Idris. The wind was slight and visibility 2-4 n.m. Two minutes after leaving the ground, the pilot, Capt. E. D. M. Jones, reported a failure of the port engine, turned to port and completed the downwind and base legs of the circuit, but the aircraft crashed 1,200 yd from the runway threshold as it was turning on to its final approach. There was only one survivor among the 35 on board.

After establishing that the Viking was correctly certificated, had a valid certificate of maintenance and was correctly trimmed and loaded, the court studied the handling of the aircraft following the failure of the port engine. It was pointed out that the performance schedule showed that the Viking should have been capable of climbing on one engine at 155 ft/min or, at continuous take-off power, at 250-300 ft/min. The court concluded that Capt. Jones "made an unhurried and not unduly worried circuit to port, probably losing height as he did so . . . he may have turned slightly wide when turning on the final approach." [It had been suggested that the runway lighting—since extended—was inadequate, but the Commissioner concluded that "it had no effect."] At a later stage on the circuit the captain requested the QFE [barometric pressure at airfield level] at Blackbushe, an action upon which the Commissioner commented: "I cannot help thinking that the lack of any anxiety on board, and the failure to attempt to gain height . . . tend to indicate that Capt. Jones thought his aircraft a good deal higher than it was, and that he may have been relying on an altimeter on which QNH [regional pressure setting] at Chatham had been set." This supposition was partly supported by evidence from the wreckage; one altimeter which was found was set at about QNH pressure, although the other—which could feasibly have been set at QFE—was not recovered. But "it is curious to note that the aircraft when proceeding to take off never asked for the QFE . . . The request for the QFE at so late a stage of the circuit may indicate the sudden realization that all was not well. The fact that the flaps were not used is perhaps a further indication to the same effect. The sudden shudder described by 2Lt. Taylor [the only survivor] is the normal precursor of a stall. The fact that the tip of the port wing struck first is exactly what was to be expected in the case of an aircraft whose port engine was dead and which had lost flying speed. Everything points to the fact that Capt. Jones had no idea that the aircraft was so low; he made no attempt to climb and had his undercarriage down, thereby of course increasing the stalling speed, and stalled his aircraft some 1,200 yd from the runway threshold he was seeking to reach."

Evidence as to the qualification of the crew was then examined. Capt. Jones ("a deliberate sort of man who . . . did a very good job on the ground as well as in the air—a very reliable man") had flown a total of 6,800 hr—4,800 hr on Vikings—and had made 36 night landings in Vikings at Blackbushe in the 18 months prior to the accident. After considering in detail the group rating, instrument rating and six-monthly tests undergone by the Viking captain, the Commissioner commented that "there is no satisfactory evidence that in the course of his employment by Eagle Aviation, Ltd., Captain Jones was ever required to land an aircraft at night on one engine"; and, that "So far as the six-monthly tests are concerned . . . I am satisfied that they did not amount to satisfactory tests to satisfy the regulations." He then added, "It is reassuring to observe that Eagle Aviation had started to put its house in order a considerable time before May 1957."

Recommendations concerning the various tests were (1) Group rating test: if the responsibility for this test is to be placed upon operating companies, examining pilots should be approved by the M.T.C.A. The form used should specify the take-offs and landings involved, and the times of each, whether by day or night, should be stated. (2) Instrument rating renewal test: part three of the test (the procedure for landing by instruments and overshooting) is only to be carried out in the course of a special flight. (3) The six-monthly check: insofar as this involves landing with one engine inoperative, insistence should be placed upon it being conducted on a special flight; every other test ought to include a night landing with an inoperative engine. Finally, it was also suggested that consideration should be given to instruction of the passengers in the location and manipulation of emergency exits.

Napier's Eland Convair takes-off through mud at Luton after a run starting from the parking area near the factory. This picture, first published in a local newspaper, provides evidence of Napier's difficulties in maintaining all-weather test flights from Luton Airport.



The first of the new 810/840 breed of Viscounts takes shape in the Vickers factory at Weybridge. It is the first of 15 for Continental Airlines of Denver, Colorado, due for delivery early next year. In the background is the Hughes Tool Company's Viscount, which has been awaiting delivery under dust-covers for more than a year.

THE NOISE OF THE COMET

THE Comet 3, which returned to Hatfield on November 11 after successfully completing its take-off and landing trials at Johannesburg, is to undergo noise-measurement tests at Hatfield. The Port of New York Authority, the world's most noise-conscious airport authority (it has banned all jet aircraft but the Caravelle from its airports) is to co-operate with Rolls-Royce and de Havilland in a programme of measurement of the noise characteristics of the aircraft fitted with Rolls-Royce jet-noise suppressors. The programme may last about two weeks, and the P.N.Y.A. may announce its findings before mid-December.

Stockholm's airport authority measured the noise of the Comet 3 on its visit to Sweden last June (before the suppressors were fitted) and said that the Comet made no more noise than the latest piston-engined and turboprop airliners.

As reported last week, Aeronaves de Mexico's first Britannia 302 arrived in Mexico City on November 4. These pictures, taken at Bristol before the aircraft left, show the elegant interior and exterior styling of the aircraft. Aeronaves services to New York will start on December 6.

NUTTS CORNER INQUIRY?

THE Minister of Transport and Civil Aviation, Mr. Harold Watkinson, was asked in the House of Commons recently whether a public inquiry would be held into the accident to the B.E.A. Viscount 802 G-AOJA at Nutts Corner, Belfast, on October 23.

The Minister replied that the Chief Inspector of Accidents was conducting a detailed investigation, and that "in accordance with normal procedure I shall decide when I see his preliminary report whether the circumstances justify a public inquiry."

The Minister was then asked whether it was not unusual for these preliminary inquiries to take so long before it was decided whether or not to have a public inquiry. The Minister explained that the only delaying circumstance was the damage to, and dispersal of, the wreckage. However, at the time this issue of *Flight* went to press, nearly three weeks after the accident, it had still not been decided whether to hold a public inquiry.

The Minister's account of the accident, which he gave in the Commons on October 30, made it clear that the aircraft was not under G.C.A. control when it crashed. The Minister's report was as follows: "At approximately 1645 hours, in conditions of low cloud and rain, an approach to runway 28 was made, using the ground-controlled approach. On completion of the G.C.A. talk-down, the pilot commenced to take normal action to overshoot. Almost immediately afterwards the aircraft crashed near the up-wind end of the runway."

BREVITIES

A POSSIBLE order for three Comet 4Bs from Pacific Western Airlines of Vancouver is reported by the American *Aviation Daily*. The order would depend on the award of a new route between Vancouver and Windsor, Ont.

* * *

K.L.M.'s United Kingdom general manager, Mr. William de Mier, has been appointed general manager in Mexico. His successor will be Mr. Willem A. Kermer.

* * *

Mr. George Gardner, president of Northeast Airlines, has said that his order for Britannias (postponed last September) depends upon C.A.A. certification being achieved by May 1, 1958.

* * *

There were reports last week that engine fuel icing in jet transports is causing concern. The implications of this are discussed in an article on page 770.

* * *

A new Dutch independent operator, to be known as Aviameer Airlines, has been formed in Antwerp (Deurne). The director is Mr. Alfred Meerbergen, and the commercial manager is Mr. Paul Hazelof.

* * *

International Aeradio announce that the air traffic control and telecommunications services in the Sudan have now been handed over to the company's senior representative there, Mohammed Abdulla Maghrabi Effendi.

* * *

K.L.M. have ordered three Lockheed 1049Hs for delivery in 1958, and Swissair announce a DC-7C repeat-order for one aircraft to be delivered early in 1959, increasing their DC-7C fleet to five. Swissair have ordered a DC-6A also.

* * *

For a reason which is not clear, 300 Bahamas taxi drivers rioted at Windsor Airport, Nassau, on November 3, demolishing a building and causing the diversion of flights by driving their taxis on to the runways.

* * *

Croydon Chamber of Commerce and Croydon Airport Users' Association were opening last Wednesday an exhibition to enlist the support of local residents in keeping the airport open. The exhibition—at the Central Baths, Croydon—will be open every day from 2-10 p.m. until November 23.

* * *

As *Flight* went to press, a PanAm Stratocruiser was still missing after being reported overdue on a flight from San Francisco to Honolulu on Saturday, November 9. There were 44 people on board. A large-scale search by aircraft and ships (including three R.A.F. Shackletons from Christmas Island) has so far been unrewarded.

Aeronaves de Mexico, who are now taking delivery of their Britannia 302s (see heading pictures), announce the signing of a contract for three Lockheed Electras. This brings the Electra order-book to 146 aircraft ordered by 13 airlines.

* * *

Ceskoslovenske Aerolinie have taken delivery of the first of their three Tu-104As. The other two will be delivered early in 1958. The airline intends to operate Tu-104 services between Prague and Moscow, on the Prague - Cairo - Beirut - Damascus route, and possibly on the Prague - London service eventually.

* * *

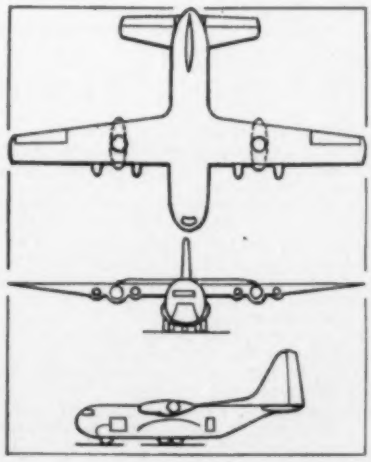
South African Airways have decided to re-equip with jet airliners, and their choice will be announced within the next six weeks. The three types being considered, for an order worth about £5m (including spares), are the Boeing 707, Douglas DC-8, and de Havilland Comet 4 or 4C.

* * *

The London consultant firm of Saben, Hart and Partners are studying the design of an 1,800-passenger, 3,000,000 lb flying-boat airliner and freighter/tanker. The freighter version would have a span of 470ft, and a payload of 1,000,000 lb, and be powered by eight turboprops of about 25,000 s.h.p. each. The airliner would carry its passenger load at a speed of 650 m.p.h. For simplicity there would be no windows. Extensive use of dimpled steel sheet (the German "Calottan" technique) would be used.

* * *

Icelandic Airlines' total trans-atlantic passenger-mileage increased by 25 per cent in 1956. Icelandic, who have two Electras on order, operate four DC-4s on low-fare (non-I.A.T.A.) trans-atlantic services between New York and the United Kingdom via Iceland.



On these pages we recently recorded Lockheed's references to nuclear-powered transports. This scheme, which shows the positioning of the reactors, is obviously based on the C-130.

Portable Airborne D/F

Good Performance from Marine Equipment

DURING a recent two-hour flight between Croydon and Hurn, the Homer transistorized receiver and Heron D/F. aerial were successfully tried in *Flight's* Gemini. Now being produced by Brooks and Gatehouse, Ltd., of Lymington, Hants, the Homer and Heron are completely portable and require neither mounting brackets nor external power supply. In the Gemini, which has a wooden airframe, good bearings and very accurate homing were obtained on Epsom and Dunsfold ranges, the marine beacon at St. Catherine's Point (I.o.W.), Southampton Water N.D.B., and Hurn range. Brookman's Park beacon and Chatham range had previously been received adequately from an extremely unfavourable location on the eighth-storey flat roof of our London offices.

The Homer receiver weighs 5.5 lb, measures 8in × 4⅞ × 2⅞in, contains seven germanium transistors and will operate with earphones for 500 hours on its pack of four Mallory RM-522 dry cells. Being primarily designed for yachtsmen, the radio is contained in a hermetically sealed aluminium case and all shafts are also sealed. Controls are provided for waveband selection, tuning with a precision-calibrated dial, broadcast/navigation (B.F.O.) selector and volume control. Leads six feet long are provided to connect with the aerial and earphones. Frequency is from 150 kc/s to 1,550 kc/s, a coverage which encompasses marine and aeronautical beacons and ranges, Consol, and medium- and long-wave broadcasts. The sensitivity provides for taking bearings at distances at least equal to the listed ranges of the beacons.

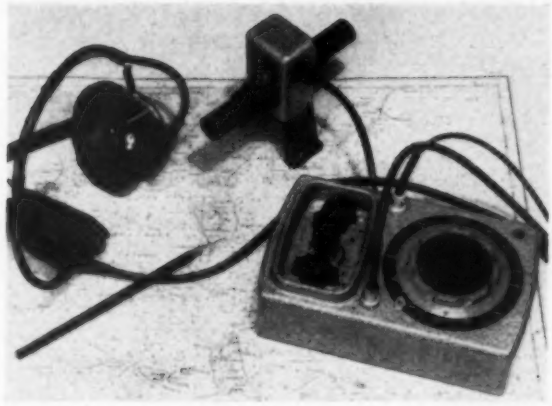
The price of the receiver, earphones and D/F. aerial is £62 10s complete. The cost of the Sestrel Junior compass adaptation, which is a new one, has not yet been fixed, but will be approximately £5.

The Heron aerial is a ferrite rod unit some 3½in tall which, with the little Sestrel Junior compass fitted on top of it, can be very comfortably held in the hand for taking bearings. Operating procedure is to tune the receiver to the listed frequency of the beacon or range required, tune the aerial unit to the same frequency, listen for the identifying Morse signal from the transmitter, and then rotate the aerial until the extremely sharp aural null shows the direction in which the transmitter lies. The D/F. magnetic bearing is read directly from the Sestrel compass.

If a sense aerial is installed in the aircraft, a "to-from" indication can also be obtained; if not, a turn through 90 deg and subsequent observation of the direction of magnetic bearing change will quickly give such an indication. A bearing from another beacon would also resolve ambiguity.

We found the aural null very sharp at ranges of about 20 n.m., and compass bearings could be easily read down to a few degrees. We homed by turning until the rod aerial, which was held continuously in the null position, lay along the fore-and-aft axis of the aircraft, and then "following" it to the transmitter. The As, Ns and equi-signal legs of range stations were very clearly received and used in the normal way. Of the soft rubber, sound-excluding type made by S. G. Brown, Ltd., for tank crews, the earphones are extremely comfortable and light.

During the trial run in the Gemini we flew exactly over the range stations at Epsom and Dunsfold without at first realizing it, but the 90 deg turn technique gave a quick and definite indication of sense in a matter of 30 sec or so. Homing directly overhead Dunsfold we noticed the station passage very clearly by a broadening of the null and by the fact that the bearings caused us to rotate the aerial through 180 deg. Flying at 4,000ft above about two-eighths cloud we easily found the actual masts of the range station by banking sharply at the right moment and looking about below the aircraft.



The Homer receiver (right) and Heron D/F aerial (centre), together with the lightweight earphones at left, are here compared for size with a normal pencil. The receiver is battery-operated and transistorized.

From the Portsmouth area we homed on the Southampton Water beacon and managed, at just over 1,000ft, to fly round it in tight circles with the aerial pointing at a constant angle to port. Looking over the port wing we were able to identify the white mast alongside some buildings on which we concluded the aerial must be mounted. Using the hand-held aerial and compass at 2,000ft we obtained a bearing of 280 deg from Beaulieu to Hurn range; the correct bearing was 279 deg. We managed quite comfortably to hold Heron and control column in one hand and made our way across country from beacon to beacon without difficulty. The weak St. Catherine's Point beacon we received at 35 miles.

The caution and intelligence required when using any A.D.F. equipment would have to be applied to the use of Heron and Homer. But although this equipment would probably not be accepted as an aid for I.M.C. airways flying, its efficiency, complete portability, light weight and low price make it ideal as an effective aid to general navigation for private owners and club pilots. One installation with a sense aerial has already been made in a Chipmunk and is reported to be giving satisfactory results. For aircraft with V.H.F. radio, the Homer signals can be fed into the standard V.H.F. earphones through a mixer box. The Homer's own volume control would allow navigation signals to be faded out when not required.

The two units are robustly built for use in fishing vessels and yachts and will withstand even complete immersion in water for long periods. They should therefore stand up well to the general wear and tear of light aircraft work. We found tuning, sensing and homing very simple and very accurate for cross-country flying. During sea crossings, or in limited visibility, Heron and Homer should prove an invaluable aid.

THE INDUSTRY'S DILEMMA (continued from page 781)

"The third alternative is nationalization. Unless the industry is prepared to act quickly it is a sitting target for nationalization, but I can only state that in my humble opinion it would be a most ghastly alternative."

Lord Weeks went on to say that if, as he was advocating, the industry must get on quickly with some form of rationalization, equally obviously it could not do so entirely on its own: Her Majesty's Government would have to play ball as well:—

"First, by really doing something about Transport Command instead of paying annual lip-service to it. We must build up the Command not only as an R.A.F. movements policy, but also as a national acceptance of the need to have Government support for British aviation; the Government should say now that they will order for Transport Command batches of the new airliners which are to be brought out. One of the vital requirements to deter or suppress limited war is a strong Transport Command.

"Secondly, by encouraging the independents to purchase new aircraft, by giving them worthwhile contracts with a reasonable future and security. I regard this as one of the most important recommendations of the Thomas Committee. The independents must be able to buy the right kind of aeroplane and, in addition, the Government could lease machines to them.

"Thirdly, by realizing that the aircraft industry cannot exist without adequate monies spent on research and development; and by recognizing that the far-reaching effect of such research and development is of the greatest importance throughout the whole engineering industry of this country from the point of view of fatigue, metallurgical and many allied problems."

"I will sum up," said Lord Weeks, "with two broad recommendations: First, someone, or some body, should try to reorientate the duties and organization of the Services and their supply. Second, someone or somebody should try to create a focus for the control of the aircraft problem, especially the civil one. These two points are necessarily very much interlocked; and that success can be achieved only by co-operation between Her Majesty's Government, the industry and the operators adds to the difficulties."

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns: the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Technicians' Status in America

IN your October 4 issue "Another Aircraft Technician" asks for "some constructive comments" on the technician and his status in the aircraft industry in Britain. I am an engineer (senior draughtsman in Britain) and have worked in one large aircraft company in Canada, and three aircraft companies in the U.S.A. (two small and one fairly large) and so I think I can give some opinions on the subject of status on the North American continent. Below are listed a few of the conditions obtaining in Canadian and American engineering offices:—

(1) I have never heard of a company whose starting hour is after 8 a.m. At least one large West Coast company starts at 7.30 a.m.

(2) The working week is never less than 40 hours.

(3) Usual lunch-hour break is 45 minutes. In a good many companies it is only half-an-hour.

(4) Tea breaks both in the morning and afternoon are unheard of on this side of the Atlantic. You may, however, bring your Thermos into the office.

(5) "Clocking-on" is the accepted way for all engineering personnel, except in the very top echelon, to register arrival time in the morning.

(6) Senior staff status and attendant privileges have never been heard of.

(7) Reference tables are never provided. Your drawing-board is 6ft × 3ft 6in and that has to be used to spread your drawings on, as well as to make your layout, general arrangements and details. (If ever you see a lush picture of an American engineering office in an advertisement or such, just notice how crowded the office is, and the absence of reference tables.)

(8) Sick leave and sick benefits in the U.S.A. do not even approach those obtaining in Britain *before* the National Health Scheme. Do not expect to get more than ten days' sick leave in the first year, and not much more thereafter. It is always very expensive to be ill.

(9) Paid national holidays are eight in number, but all occur as single days, mostly in the middle of the week. As an example, Christmas Day this year falls on a Wednesday, therefore the Christmas holiday is *one day only*. Good Friday is not a national holiday, and is a State holiday in only 12 out of the 48 States.

(10) Except in a few isolated cases, unions are non-existent in engineering offices, which goes far towards explaining why engineering personnel facilities and privileges are not up to accepted British standards.

Even so, with these obviously poorer working conditions, there is a greater incentive to work, and a much greater sense of urgency to "get the job done." And so this is my advice to you technicians and draughtsmen at home—Go to it and get the job done so that you can sell more Britannias, Vanguards, Comets, etc., to the Americans before they decide it's time they "bought up" a decaying British aircraft industry.

Newtown, Conn., U.S.A. EDMUND J. WEISS.

Restrictions on the Private Pilot

PRIVATE pilots all over the country are extremely mystified by the fine which was levied on Mr. A. M. Harris for landing at Eastleigh in bad weather (*Flight*, October 4). Unfortunately, Mr. Harris (probably like myself in a similar case over a year ago), thinking that he had committed a purely technical offence and not being able to take time off from his business, pleaded guilty, and was not defended; so we cannot really complain if the magistrates decided to levy a fine.

But what is so surprising is that a prosecution should have been launched at all in connection with this landing at Eastleigh. Schedule II, Section II, para. 2 of the Air Navigation Order 1954 is perfectly clear when it says that *if a pilot lands as a result of bad weather or in order to avoid immediate danger, provided he is able to explain himself, he is not breaking the regulations.*

In addition to this, according to the evidence given at the Eastleigh Magistrates' Court, the Auster which Mr. Harris was flying was shown on the airport radar screen, and the controller knew exactly where it was; therefore, there was no suggestion of danger to other aircraft.

Can anyone enlighten private fliers, please (and they are very worried about this sort of case, because it is the kind of thing which can happen to anyone) as to why such a prosecution was launched?

Claygate, Surrey. NORMAN JONES.

[Mr. Harris was fined £25 and ordered to pay 10 gns costs—Ed.]

EARLIER this year this Association was approached by a young man with an artificial eye, who explained that the M.T.C.A. would not grant him a Student Licence, enabling him to fly solo. He further explained that four different flying instructors had given him certificates to say that his flying was quite up to standard, and one instructor confided in me that he flew better than many two-eyed pilots.

This Association advised the would-be airman to discuss the matter with the licensing department at the Ministry. The first question he was asked at the interview was, "Well, why do you *want* to fly?" It leaves little to the imagination to appreciate what headway the young man made with the department concerned.

Seeing no reason why a one-eyed pilot would be any worse than a two-eyed pilot in a modern aircraft with its built-in blind spots, we went in to bat for him, and at the time of writing are still hoping to hit the Minister for six. However, in many instances when someone kicks over a stone interesting revelations result. From patient probing by an "inquiry agent" not only do we discover that there are a number of one-eyed pilots, but that there were, in fact, two pilots who were given their Student Licences and learned to fly from scratch, using one normal eye and one made of plastic!

On putting up this information to the Minister we received the reply that he had "nothing further to add but thanks you for the letter"(!) We are still battering at the Minister, and trust that sense will prevail before block-busters are brought into use.

No wonder our streets are full of Teddy-boys when Young England gets this sort of treatment from people who are paid out of the public purse to assist and encourage would-be aviators. Imagine the storm of protest if a would-be motorist was asked on application "why do you want to drive a car?" Can you imagine the reply! Can you imagine how far the public servant would be bounced for asking such a question? Why let the M.T.C.A. get away with it?

M. J. CONRY,
Hon. Secretary, British Aeroplane Owners and Pilots Association.

E. Grinstead, Sussex.

WE are constantly being asked: "Why not more private owner and club flying?" The newspaper cuttings enclosed show one of the answers. [Our correspondent encloses reports of the case referred to in Mr. Norman Jones's letter—Ed.] Private flying has flourished for years in France and America, where one is helped—not hindered by petty restrictions. Believe me, to travel about today by air one should carry a good solicitor.

Incidentally, I have been a reader of *Flight* since, I believe, 1909, and your first editor, Mr. Spooner, found me my first job in aviation in 1910; I have been in it or connected with it ever since. I am an old member of the original London Aeroplane Club at Stag Lane, where I obtained the then standard Civil Pilot's Licence. There was a wonderful spirit and very little money—most of us had none—but we got about. One recalls such names as Lady Bailey, Winifred Spooner, Will Hay, Gordon Store, Scott-Taggart, etc. Among the instructors were Sparkes and St. Barbe (brother of the present D.H. director) and Baker (later of Martin-Baker).

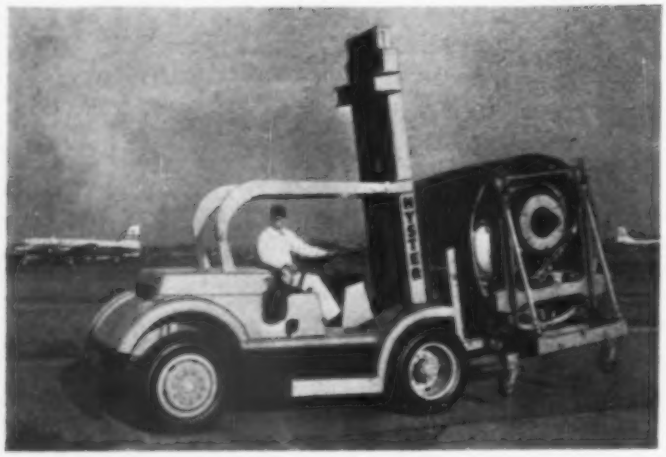
Bristol. H. S.

FORTHCOMING EVENTS

Nov. 15. Institute of Navigation: Discussion on Doppler Navigation.
Nov. 19. R.Ae.S.: Section Lecture: "The Supersonic Wind Tunnel," by Dr. W. F. Hilton, F.R.Ae.S.
Nov. 20. Kronfeld Club: Talk by Peter Scott.
Nov. 21. R.Ae.S.: Guided Flight Section: Inaugural Lecture: "Guided Weapons and Aircraft: Some Differences in Design and Development," by J. E. Serby, C.B.E., B.A., F.R.Ae.S.
Nov. 26. R.Ae.s.: Section Lecture: "Some Aspects of Refrigeration in Supersonic Aircraft," by E. J. Gabbay, A.F.R.Ae.S.
Nov. 27. British Institution of Radio Engineers: A.G.M.
Nov. 27. Kronfeld Club: Talk by Wally Wallington.
Nov. 27. R.Ae.S.: Graduates and Students Section: "Flight-Testing Procedures at Supersonic Speeds," by W/C. R. P. Beamont, D.S.O., O.B.E., D.F.C.
Nov. 29. R.Ae.S.: Graduates and Students Section: Annual Dance.
Dec. 3. R.Ae.S.: Section Lecture: "Some Techniques of Engine Testing under Simulated Icing Conditions," by O. R. Ballard, A.F.R.Ae.S., and P. J. Sharp.

R.Ae.S. Branch Lectures (to Dec. 3):—

Nov. 18, *Halton*, Film Show. Nov. 19, *Luton*, Debate. Nov. 20, *Christchurch*, "Operation and Maintenance of High Altitude Aircraft," by Personnel of the U.S.A.F.; *Southampton*, Fifth Mitchell Memorial Lecture: "The Developments of Propulsion Systems for High Speed Flight," by Dr. S. G. Hooker; *Weybridge*, "Medical Aspects of High Performance Flying," by G/C. H. P. Ruffel Smith. Nov. 27, *Hatfield*, "Experiences of an Airline Pilot," by Capt. O. P. Jones. Nov. 28, *Bristol*, Junior Members' Paper Competition; *Halton*, Film Show. Dec. 3, *Boscombe Down*, "Weapon System Concept," by H. Davies.



This Hyster RC-150 fork lift truck, seen in use at London Airport, is powered by a Perkins P6(V) diesel. Made by F. Perkins, Ltd., Peterborough, this engine is capable of developing 83 b.h.p. at 2,400 r.p.m. Five types of Hyster fork-lift trucks (made by the Dutch subsidiary of an American company) and the Hyster Karry Krane have Perkins engines.

THE INDUSTRY

Paraffin Mist Collector

SPRAYING engine castings and other parts with paraffin at high pressure after machining or overhaul inevitably results in mist rising; and as a means of suppressing this a new device—the "Garda" paraffin mist collector—has been produced by the dust control division of B.S. Developments, 14 Marlborough Road, Woking, Surrey.

Mist-laden air is drawn by a fan into a grille-protected chamber and then enters the scroll inlet of a static turbo-separator. The high velocity of the globules causes them to gyrate to the walls of the separator, whence they run down into a storage tank, while the cleaned air passes up through the central core to the fan and thence out to the air in the building.

These units—two of which, say B.S. Developments, are already showing "extraordinarily good results" at an aircraft firm in the West of England—can be arranged in multiples with ductwork connecting several spray-booths, with a central plant which can either return paraffin to the main tank or have its own storage.

Goodyear Sales Appointments

FOLLOWING Mr. A. H. ("Bill") Pendree's recent appointment as sales director of the Goodyear Tyre and Rubber Co. (Gt. Britain), Ltd., there have been further changes in the company's sales department. Mr. J. Warnock, since 1949 manager of the tyre department, becomes manager of administrative services (a newly created post); and Mr. A. Thomson (previously sales development manager) has been made sales manager, tyre replacement department.

Mr. Warnock joined the company in 1928 and was made a district manager in 1935. After the war (when he served in Tyre Control as a regional officer) he rejoined Goodyear's as executive assistant to the sales director. In his new post he will have responsibilities relating to all departments. "Sandy" Thomson also joined Goodyear in 1928, becoming district manager of the northern division sales force after transferring to it in 1937. He served with the R.A.F. during the war, rejoining the company in 1946 and two years later going out to Goodyear-South Africa. Mr. Thomson returned to this country last year to take up the managership of the sales development department.

This instrument casing, made from two halves of mild steel pressing and an additional centre section of mild steel, illustrates an application of Bakelite epoxide resins (referred to in a paragraph on the "Industry" page of "Flight" for September 13) for making press tools.

IN BRIEF

Mr. D. F. Ringe, formerly chief designer of Vokes, Ltd., has been appointed general manager, and Mr. K. D. Mulcaster, previously chief draughtsman, becomes chief designer.

* * *

Ransome and Marles Bearing Co., Ltd., have acquired exclusive British rights for the manufacture and sale of Thomson ball bushings, a type of linear bearing widely used in America.

* * *

Mr. Edwin King, who joined Black and Decker, Ltd., in 1954 as accountant and in January last year became budget controller, has now been appointed assistant company secretary.

* * *

Uhlhorn Brothers, Ltd., are now in production at their new factory where, they state, "all work will be carried out under modern conditions." Their address is now Oliver House, 51/53 City Road, London, E.C.1.

* * *

Among British exhibitors at the International Macroplastic Fair which opened in Amsterdam two days ago are Bristol Aircraft, Ltd. Their exhibits include a plastic 100-gallon aircraft drop tank; a glass-fibre cooling fan and air duct assembly as used in the Sycamore; resin impregnated glass-fibre high-pressure vessels; and rocket-motor tubes of resin-impregnated glass fibre.

Formerly with the R.A.F. from 1938 until he joined the National Benzole Co., Ltd., last year as assistant to the transport manager, Mr. A. Morris, M.B.E., has now been appointed manager of the company's motor transport department.

* * *

Shell have completed construction of a 2¾ million-gallon aviation fuel storage tank for Frobisher Bay Airport, Baffin Island, on the transpolar air route between Europe and the west coast of America.

* * *

Mr. L. J. W. Bailey, chief purchasing agent of the Dunlop Rubber Co., Ltd., for the past five years, has been appointed general manager and a director of the India Tyre and Rubber Co., Ltd. He is succeeded as chief purchasing agent by Mr. D. W. Hawkins, director and general manager of Dunlop Plantations, Ltd.

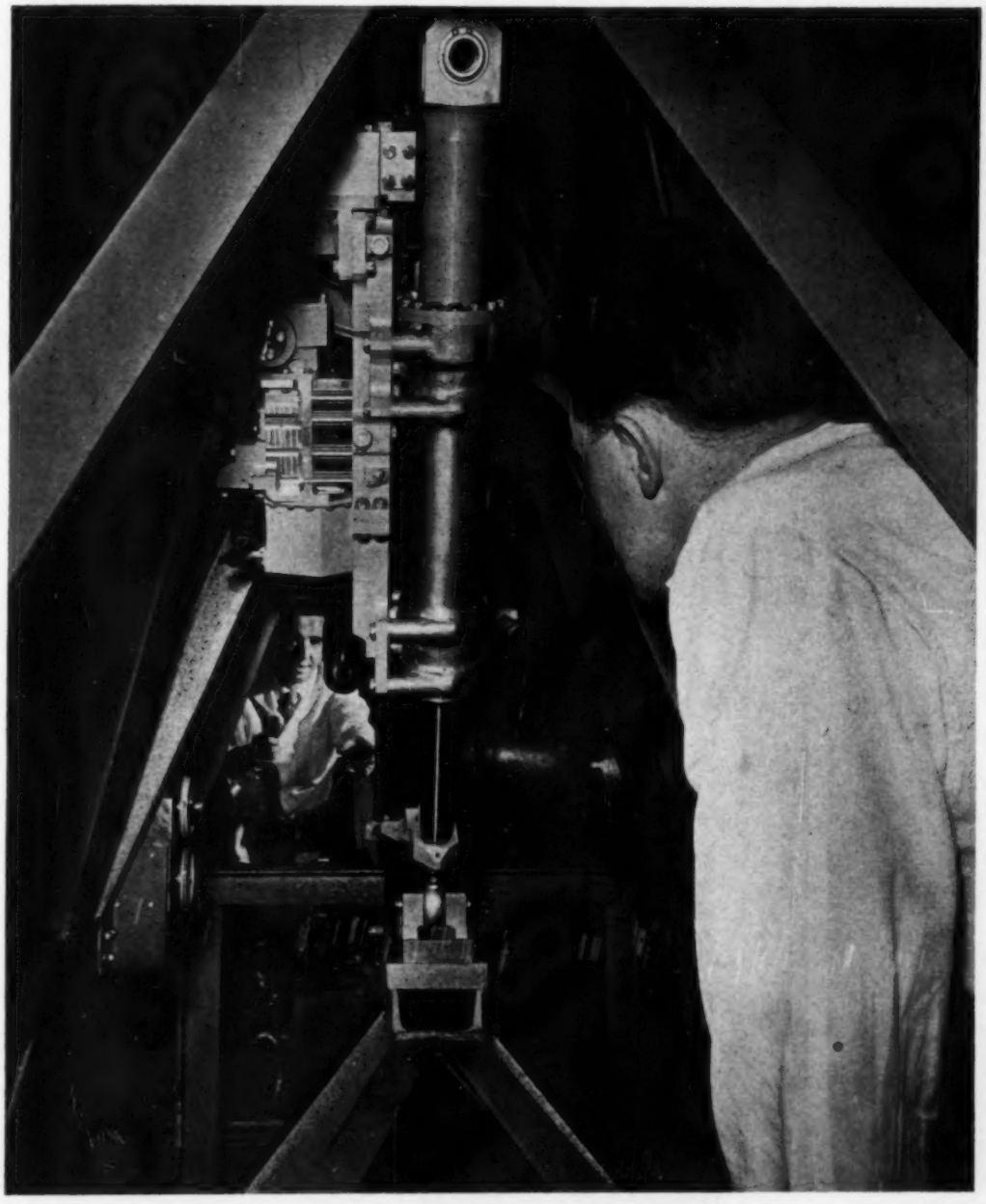
* * *

Recent appointments have been announced by two subsidiaries of Sheepbridge Engineering, Ltd. Mr. J. J. Carroll has joined Sheepbridge Stokes, Ltd., as manager of the single-cast-ring foundry; and Mr. A. E. Akerman has been appointed sales director of Harold Andrews Sheepbridge, Ltd., Mr. B. C. Goodwin continuing as sales manager.

Mr. G. R. Scott-Farnie (left), general manager of International Aerodio, Ltd., is to become managing director on January 1. He succeeds A. Cdre. C. S. Cadell, who is understood to be joining "The Times" newspaper.

Mr. George Howell (right), chief accountant of Alvis, Ltd., who has been appointed to the Board of directors. He joined the company in 1940 as cost accountant and became chief accountant in 1947.

From Folland Aircraft, Ltd., comes news that Mr. C. F. Stevens (right) has joined them as chief inspector. Previously, from 1931, he was with Hawker Aircraft (from 1951 to 1957 as chief inspector of their Blackpool factory) except during the war period, when he served in the Technical Branch of the R.A.F., attaining the rank of squadron leader.



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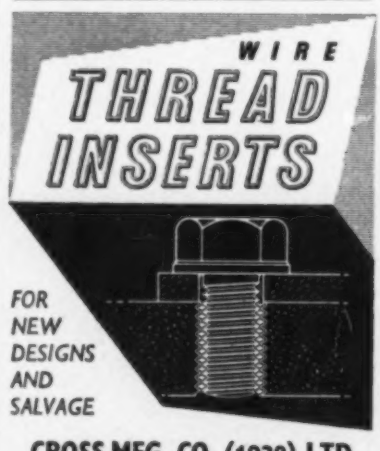

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FURTHER particulars and forms of application are obtainable from the Secretary, to whom applications should be sent as soon as possible.
J. S. TAIT, Ph.D., B.Sc.(Eng.), M.I.E.E., Principal. [7296

Jersey Civil Service

A VACANCY exists at the States of Jersey Airport for an additional Air Traffic Control Officer. Possession of a Ministry of Transport and Civil Aviation Certificate with Approach Control, Areodrome Control and Traffic Director (Radar) Ratings will be an advantage. Applicants must be between the ages of 23 and 35. Commencing salary within range £600 to £1,100 according to experience, with possibility of promotion to higher grade with maximum of £1,250.
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F. de L. Bois,
Greffier of the States. [7293

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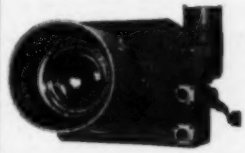

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AIR TRANSPORT ADVISORY COUNCIL

THE AIR TRANSPORT ADVISORY COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services:
APPLICATION No. 1533 from Starways, Ltd., of Liverpool Airport, Liverpool 19, for a U.K. Internal Service with Dakota aircraft for the carriage of passengers between Glasgow (Renfrew) and Jersey at an initial frequency of four return flights weekly increasing later in accordance with traffic demand for a period of seven years from 1st June, 1958.
APPLICATION No. 96/3 from Silver City Airways, Ltd., of 1 Great Cumberland Place, London, W.1, for an amendment of the terms of approval of the Normal Scheduled Service which they are authorised to operate until 30th March, 1960, with Dakota, D.H. Heron and Viking aircraft at a frequency of up to three return flights weekly on the route Newcastle-Paris or, in combination with another service, on the route Newcastle-Liverpool-Paris, so as to permit instead operation with Dakota, D.H. Heron and Bristol 170 aircraft on the route Blackpool-Liverpool (optional)—Paris.
THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7294

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For example, the Britannia linked New York and Rome in 12 hours 20 minutes—4,700 miles—at an average speed of 382 mph, and with an 18,000-lb payload.

And from London to Vancouver—the Britannia covered 5,100 miles in 14 hours 40 minutes, with a payload equivalent to 61 passengers and baggage.

Powered by four 4,120-hp Bristol Proteus engines, the Britannia maintains matchless standards of efficiency and economy over the longest stage lengths.

For many months now the Bristol Britannia has been in service with BOAC throughout half the world. Britannias are being delivered to Aeronaves de Mexico and El Al Israel Airlines, and have been ordered by Canadian Pacific, Cubana de Aviacion, Hunting-Clan Air Transport, Ministry of Supply, Northeast Airlines and the Royal Air Force.

BRISTOL

Britannia

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